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MODIFIKACIJE POVRŠINE ZUBNIH IMPLANTATA I NJIHOV UTICAJ NA PROCES OSEOINTEGRACIJE

MODIFICATIONS ON THE DENTAL IMPLANT SURFACES AND THEIR INFLUENCE ON THE OSTEOINTEGRATION PROCESS

Ljupka Arsovski[1], Sofija Carčeva Šalja[1], Daniela Veleska-Stevkovska[2], Mihajlo Petrovski[1], Kiro Papakoča[1], Ivan Boev[1], Maja Ristova Delipetrev[1]

[1]UNIVERZITET „GOCE DELČEV", FAKULTET MEDICINSKIH NAUKA, ŠTIP, SEVERNA MAKEDONIJA
[2]UNIVERZITET „SV. KIRIL I METODIJ", STOMATOLOŠKI FAKULTET, SKOPLJE, SEVERNA MAKEDONIJA

[1]FACULTY OF MEDICAL SCIENCES, GOCE DELCEV UNIVERSITY, STIP, NORTH MACEDONIA
[2]UNIVERSITY „SS. CYRIL AND METHODIUS", FACULTY OF DENTISTRY, SKOPJE, REPUBLIC OF NORTH MACEDONIA

Sažetak

Uvod: *Dentalna implantacija predstavlja proces ugradnje zubnih implantata u kost pacijenta na mestima gde nedostaje jedan zub ili više zuba. Da bi implantacija bila uspešna, potrebno je da dođe do procesa oseointegracije, što znači da zubni implantat postavljen u kost treba da stvori vezu sa koštću. Uspeh procesa oseointegracije zavisi od više faktora, među kojima je i biološka modifikacija materijala od kojeg je implantat napravljen. Neuspeh u oseointegraciji vodi do periimplantitisa i odbacivanja implantata.*
Cilj: *Cilj rada bio je da se dokaže uticaj hemijskih elemenata koji se pojavljuju na površini titanijumskih implantata na pojavu periimplantitisa, koji utiče na proces oseointegracije prilikom dentalne implantacije. Predmet ovog istraživanja bila je analiza novih, sterilnih implantata, kao i njihovo poređenje sa odbačenim, odnosno neuspelim implantatima.*
Materijali i metode: *Za potrebe naučnog istraživanja korišćen je skenirajući elektronski mikroskop (SEM), koji je omogućio detaljnu analizu površine implantata. Analiza je rađena na novim, fabričkim, kao i na neuspelim, obačenim implantatima. Skenirajući elektronski mikroskop vrsta je elektronskog mikroskopa koja proizvodi slike uzorka skeniranjem njegove površine fokusiranim snopom elektrona.*
Rezultati: *Posledica taloženja mnogih minerala (npr. Mg, P) jeste veća otpornost na habanje na površini implantata. Tragovi zagađivača Na, zajedno sa C, N, Ca, Al i O, takođe su otkriveni na titanijumskoj površini odbačenih, neuspelih implantata.*
Svi ovi elementi negativno utiču na uspeh implantacije i čine uzrok neuspešne terapijske procedure implantacije.
Zaključak: *Kontaminacija dentalnih implantata ključni je faktor za uspeh/neuspeh implantacije. Tragovi organskih i neorganskih zagađivača mogu se naći uprkos procesu čišćenja implantata, površinskoj obradi Ti, supstancama poput kiseline i peska.*

Ključne reči: *implantat, neuspeh, oseointegracija, periimplantitis, uspeh*

Abstract

Introduction: *Dental implantation is a process of implanting dental implants into the bone of a patient, in places where one or more teeth are missing. For successful implantation, the process of osteointegration has to happen, which means that the dental implant placed in the bone should create a connection with it. The success of the osteointegration process depends on several factors, one of which is a biological modification of the material from which the implant is made. As a failure, it can occur during peri-implantitis.*
Aim: *The present study aimed to prove the influence of the foreign body on osteointegration during dental implantation, that is, the cause of peri-implantitis. The subject of our research was the analysis of new, sterile implants and their comparison with fallen, lost implants*
Materials and methods: *For this scientific research we used a scanning electron microscope, which allows a detailed analysis of the implant surface. The analysis was performed on brand new, as well as on failed implants. A Scanning Electron Microscope (SEM) is a type of electron microscope that produces images of a sample by scanning its surface with a focused beam of electrons.*
Results: *As a consequence of the deposition of many minerals (like Mg, and P), a higher wear resistance occurs on the implant surface. Traces of contaminant Na along with carbon, N, Ca, Al and O were also detected on the Ti surface of the failed implants, which are fallen implants.*
All these elements negatively affect the implantation success and are the cause of unsuccessful implant treatment.
Conclusion: *Dental implant contamination is a key factor for the success/failure of implantation. Traces of organic and inorganic contaminants can be found, despite the implant cleaning process and surface treatment of Ti, substances such as acid and sand.*

Key words: *implant, failure, osteointegration, peri-implantitis, success*

Corresponding author:
Ljupka Arsovski, DMD, Teaching Assistant
Goce Delcev University, Faculty of Medical Sciences
42-1 Partizanska St. , Štip
Republic of North Macedonia
E-mail: ljupka.arsovski@ugd.edu.mk

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Uvod

Zubni implantati koriste se za zamenu izgubljenih zuba, odnosno za zamenu korena izgubljenih prirodnih zuba. Nakon perioda od tri meseca do šest meseci, ugrađeni implantat postiže oseointegraciju u kost – tada možemo reći da je implantacija uspela i da je telo domaćina prihvatilo „strano“ telo[1]. U suprotnom, razvija se upala oko implantata (periimplantitis), dolazi do odbacivanja implantata i neuspešne implantacije[2].

U prošlosti je postojao konsenzus da oseointegracija predstavlja homeostazu između zubnog implantata, napravljenog od titanijuma i okolne kosti. Takođe, smatralo se da je uzrok periimplantitisa upalni proces uzrokovan zubnim plakom sa gubitkom periimplantne kosti. U istraživanjima sprovedenim u protekloj deceniji navodi se nova teorija, prema kojoj je oseointegracija posledica procesa upale kao kontrolisane inflamatorne reakcije organizma na prisustvo stranog tela. Iako je implantat strano telo, telo ga najčešće prihvata zbog plemenitih materijala od kojih je napravljen.

Pojedina istraživanja zasnivaju se na ulozi koju oslobađanje materijala povezanog sa implantatima, posebno čestica titanijuma i nusproizvoda korozije, u okolno tkivo ima u pojavi i napredovanju periimplantitisa[3].

Cilj rada bio je da se dokaže uticaj hemijskih elemenata koji se pojavljuju na površini titanijumskih implantata na pojavu periimplantitisa, koji utiče na proces oseointegracije prilikom dentalne implantacije. Predmet ovog istraživanja bila je analiza novih, sterilnih implantata, kao i njihovo poređenje sa odbačenim, odnosno neuspelim implantatima.

Materijali i metode

Za potrebe ovog naučnog istraživanja korišćen je elektronski mikroskop, kojim je urađena detaljna analiza površine implantata. Analiza je obavljena kako na novim, tako i na odbačenim implantatima. Skenirajući elektronski mikroskop (SEM) vrsta je elektronskog mikroskopa koja proizvodi slike uzorka skeniranjem njegove površine fokusiranim snopom elektrona. Elektroni stupaju u interakciju sa atomima u uzorku, proizvodeći različite signale koji sadrže informacije o topografiji površine i sastavu uzorka. Elektronski snop skenira se u rasterskoj grafici, a položaj zraka kombinuje se sa intenzitetom detektovanog signala da bi se proizvela slika.

Introduction

Dental implants are used to replace lost teeth, or rather replace the roots of lost natural teeth. After 3 to 6 months, the placed implant achieves osteointegration in the bone and it is said that the implantation is successful and the body has accepted the "foreign" body[1]. Otherwise, inflammation continues around the implant referred to as peri-implantitis and the body rejects the implant and implantation fails[2].

In the past, there was a wide consensus that osteointegration represents homeostasis between the dental implant, made of titanium, and the surrounding bone, while bone loss was thought to be the cause of peri-implantitis, an inflammatory process caused by dental plaque. Contemporary researches present a new theory, according to which the osteointegration of an inflammatory process is the cause of the foreign body reaction and bone loss in response to the inflammatory process.

Furthermore, some researchers regarded the role of the release of implant-related material into the surrounding tissue, particularly titanium particles and corrosion byproducts, in the initiation and progression of peri-implantitis[3].

The aim of the study was to prove the influence of the foreign body on osteointegration during dental implantation, that is, the cause of peri-implantitis. The subject of our research was the analysis of new, sterile implants and their comparison with fallen, lost implants.

Materials and method

For this scientific research, we used an electron microscope, which allows detailed analysis of the surface of an implant. The analysis was performed on the new, as well as on the fallen implants. Scanning Electron Microscope (SEM) is a type of electron microscope that produces images of a sample by scanning its surface with a focused beam of electrons. Electrons interact with atoms in the sample, producing various signals that contain information about the surface topography and composition of the sample. The electron beam is scanned in a raster scan pattern, and the position of the beam is combined with the intensity of the detected signal to produce an image. In the most common SEM mode, secondary electrons emitted by atoms excited by the electron beam are detected by a secondary electron detector (Everhart-Thornley detector). The number of secondary electrons that can be detected, and thus the signal intensity, depend, among other things, on the sample topography.

U najčešćem SEM režimu, sekundarni elektroni koje emituju atomi pobuđeni elektronskim snopom detektuju se pomoću sekundarnog detektora elektrona (Everhart–Thornley detektor). Broj sekundarnih elektrona koji se mogu detektovati, a samim tim i intenzitet signala, zavisi od topografije uzorka, između ostalog. Neki SEM mogu postići rezolucije veće od jednog nanometra. Uzorci se posmatraju u visokom vakuumu u konvencionalnom SEM-u ili u niskom vakuumu ili vlažnim uslovima u promenljivom pritisku ili ambijentalnom SEM-u, i u širokom opsegu kriogenih ili povišenih temperatura sa specijalizovanim instrumentima.

Laboratorija za elektronsku mikroskopiju ima za cilj proučavanje morfologije i hemijskog sastava različitih materijala u visokom ili niskom vakuumu. Analiza uzoraka obavljena je SE i/ili BSE detektorom, sa dobrom pripremom uzoraka i postignutom rezolucijom više od 5 nm. Hemijska analiza vršena je pomoću EDS detektora koji može detektovati elemente od Be do Pu, sa maksimalnom rezolucijom od 125 eV. Korišćenjem ove metode dobijena je kvalitativna i kvantitativna hemijska analiza postavljenog uzorka[4].

Prvu grupu ispitivanih zubnih implantata činili su čisti implanti, koje karakteriše *TiPurePlus Pl-Line* površina. To znači da je implantat čišćen peskarenjem; sam implantat napravljen je od čistog titanijuma stepena 4, po specijalnoj, precizno definisanoj tehnologiji. Ovi implantati imaju konusni dizajn, sa zaobljenim vrhom.

SC/SCKS implantati dostupni su u standardnim prečnicima (3,25/3,75/4,1/4,5/5,5 mm) i dužinama (7/8,5/10/11,5/13/15 mm) implantata.

Dizajn druge grupe ispitivanih implantata cilindričnog je oblika, sa dvostrukom olovnom žicom i dva spiralna antirotirajuća žleba.

Implantat je u nivou kosti, heksagonalnog oblika, sa ravnom glavom i mikronitima. Telo je na vrhu suženo sa obrnuto proporcionalnim nitima. Vrh implantata je kupastog oblika, bez otvora i sa žlebovima.

Rezultati i diskusija

Taloženje mnogih minerala (npr. Mg, P) dovodi do veće otpornosti na habanje površine implantata. Otkriveni su i tragovi zagađivača Na, zajedno sa C, N, Ca, Al i O, na titanijumskoj površini odbačenih, neuspelih implantata.

Some SEMs can achieve resolutions better than 1 nanometer. Samples are observed in high vacuum in conventional SEM, or low vacuum, or wet conditions in variable pressure or ambient SEM, and at a wide range of cryogenic, or elevated temperatures with specialized instruments.

An electron microscopy laboratory aims to study the morphology and chemical composition of various materials in high or low vacuum. Analyzing the samples can be done by SE and/or BSE detector, and with good sample preparation, we can achieve a resolution better than 5 nm. The chemical analysis is performed with an EDS detector that can detect elements from Be to Pu, with a maximum resolution of 125 eV. By using this method, a qualitative and quantitative chemical analysis of the placed sample is obtained[4].

Our examined dental implants are characterized by a TiPurePlus Pl-Line surface. This means that the implant is sandblasted clean, while the implant itself is made of grade 4 pure titanium, with special, precisely defined technology used. These implants have a conical design, with a rounded tip.

SC/SCX implants are available in standard diameters (3.25/3.75/4.1/4.5/5.5 mm) and lengths (7/8.5/10/11.5/13/15 mm)) of the implants.

The design of the other examined group of implants is cylindrical in shape, with a double lead wire and two spiral anti-rotation grooves.

It is an implant at the bone level. With a hexagonal shape. Its head is straight and has microfilaments. The body is tapered at the top with inversely proportional threads. The top of the implant has a domed shape, without a hole and with grooves.

Results and discussion

Along with the deposition of various minerals (for example Mg, P), which lead to the greater wear resistance of the implant surface, traces of contaminant Na along with carbon, N, Ca, Al and O were also detected on the Ti surface of the failed implants, i.e. the fallen implants. Also, there were traces of Na detected on the implant surfaces.

All these elements negatively affect the success of implantation and are the cause of its failure.

On failed implants surface Si was detected along with P, Ca, Na, S, Cl, Zn and copper (Cu) on the Ti surface.

Tragovi Na takođe su otkriveni na površini odbačenih implantata.

Svi ovi elementi negativno utiču na uspeh implantacije i razlog su zbog kojeg ona može biti neuspešna.

Si je detektovan na neuspelim implantatima, zajedno sa P, Ca, Na, S, Cl, Zn i bakrom (Cu), na titanijumskoj površini. Smatra se da površinski zagađivači mogu pojačati inflamatorni odgovor menjajući proces zarastanja, što dovodi do promene površine oksidnog sloja i neuspeha oseointegracije.

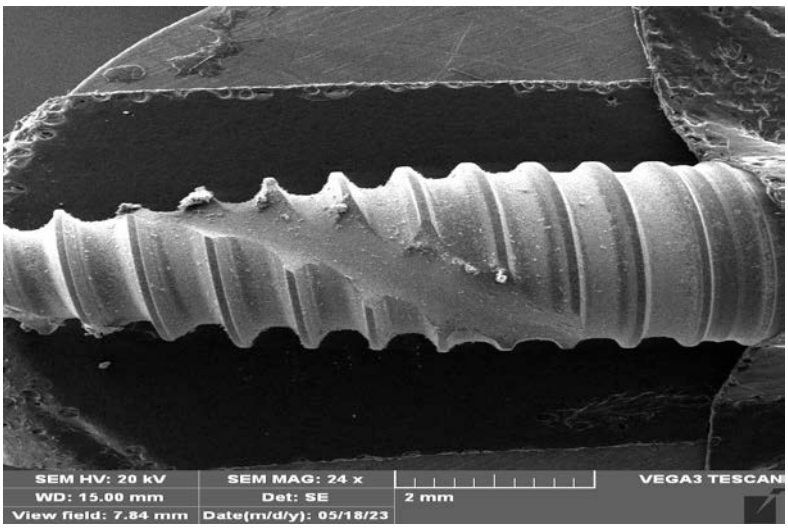
Prisustvo Si verovatno je posledica procesa pasivizacije u kojem je Si korišćen kao premaz, ili prilikom tretiranja titanijumskih površina.

U prvom test sistemu pronađena je velika količina kontaminacije Ca, što je i morfologija sigurno potvrdila. Nivo kontaminacije koju izaziva Ca od 0,0005% dovoljan je da inhibira formiranje apatita.

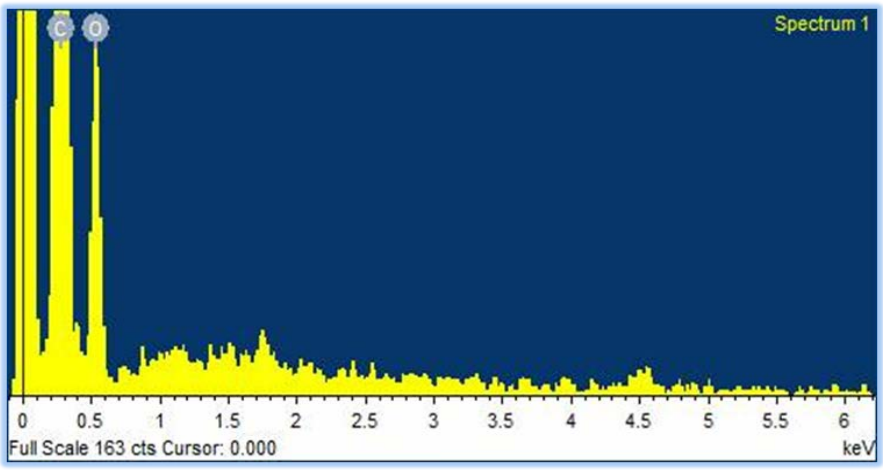
It is thought that surface contaminants may enhance the inflammatory response, alter the healing process that further leads to oxide layer surface alteration and osteointegration failure.The presence of Si is probably due to the passivation process where Si was used as a coating, or during Ti surfaces treatment.

A large amount of Ca contamination was found in the first test system, which morphology confirmed for sure. Even Ca contamination level of 0.0005% was sufficient to inhibit apatite formation.

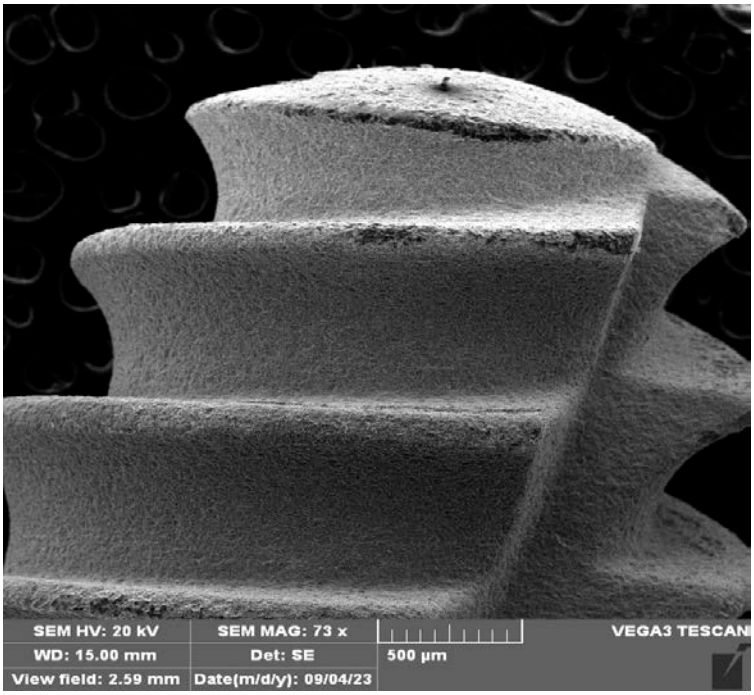
Traces of organic and inorganic contaminants can be found from the implant cleaning process, and surface treatment of Ti, like acid and sand[5].



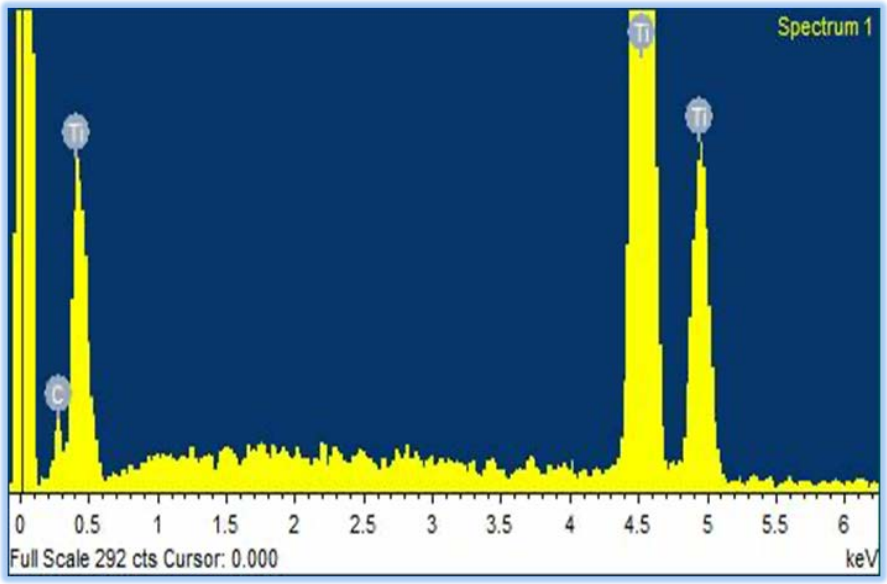
Slika 1a. Novi implantat iz prve grupe
Figure 1a. New implant from the first group



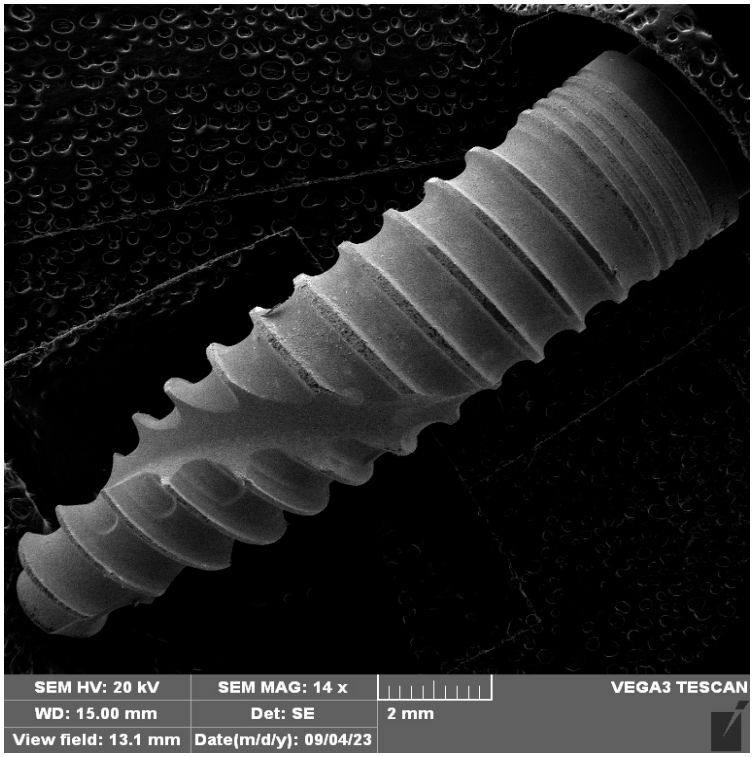
Slika 1b. Hemijska analiza novog implantata iz prve grupe
Figure 1b. Chemical analysis of a new implant from the first group



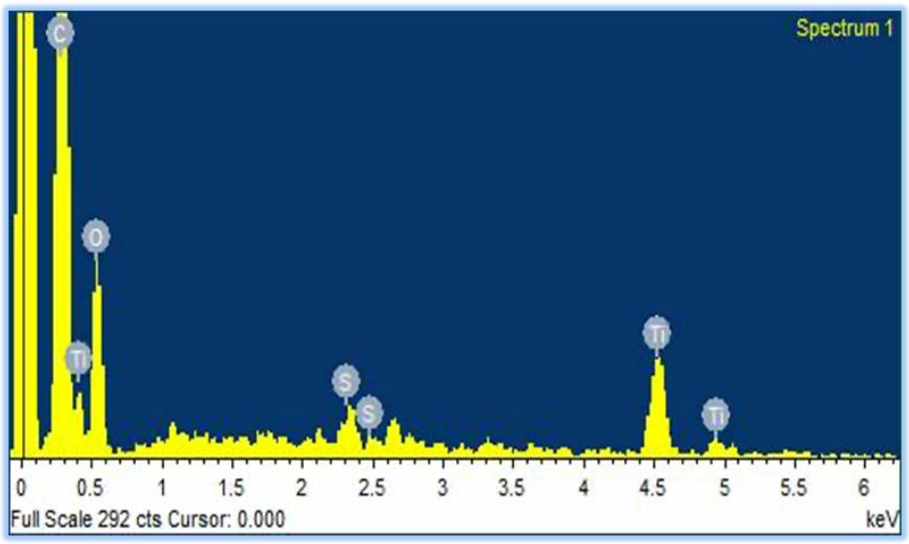
Slika 2a. Odbačeni implantat iz prve grupe
Figure 2a. Rejected implant from the first group



Slika 2b. Hemijska analiza odbačenog implantata iz prve grupe
Figure 2b. Chemical analysis of a rejected implant from the first group

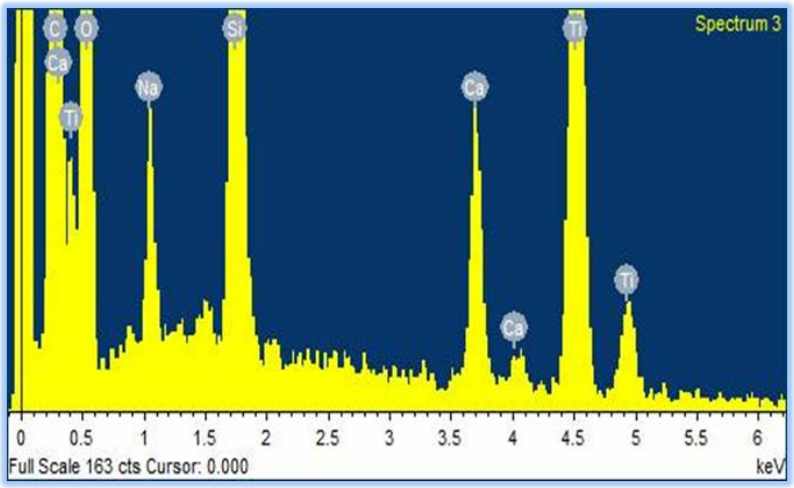


Slika 3a. Novi implantat iz druge grupe
Figure 3a. New implant of the second group



Slika 3b. Hemijska analiza novog implantata iz druge grupe
Figure 3b. Chemical analysis of a new implant from the second group

Slika 4a. Odbačeni implantat iz druge grupe
Figure 4a. Rejected second group implant



Slika 4b. Hemijska analiza odbačenog implantata iz druge grupe
Figure 4b. Chemical analysis of a rejected implant from the second group

Tabela 1. Preliminarni rezultati hemijskih elemenata na površini odbačenih implantata
Table 1. Preliminary results of chemical elements on the surface of rejected implants

Zagađivač A polluter	Način kontaminacije Method of contamination	Pozitivan efekat Positive effect	Negativan efekat Negative effect
Ca (kalcijum, calcium)	U toku čišćenja During cleaning	Kontakt kosti i implantata Bone and implant contact	Inhibira formiranje apatita Inhibition of apatite formation
P (fosfor, phosphorus)	U toku čišćenja During cleaning	Proizvodi citokine i matične ćelije Produces cytokines and stem cells	Habanje površine implantata Wear of the implant surface
S (sumpor, sulfur)	Pljuvačka, u kiselini za čišćenje Saliva, in cleaning acid		Promena površine na implantatu – oksidni sloj Surface change on the implant - oxide layer

Tragovi organskih i neorganskih zagađivača mogu se naći u procesu čišćenja implantata, površinske obrade Ti, kiselinom i peskom[5].

Zagađivači mogu biti korisni za zubne implantate i/ili imati štetne efekte na njih. Osim toga, mogu promeniti površinsku energiju, hemijsku čistoću, debljinu i sastav oksidnog sloja. Takođe je poznato da je najčešća kontaminacija titanijumske površine implantata ovim elementima potencijalno povezana sa defektima na implantatima. Kontaminacija implantata povezana je sa elementima koji se nalaze u tragovima; takvi su npr. N, Ca, P, Cl, S, Na, Si i F, organski ugljenik i bakterijske ćelije. Međutim, ima i zagađivača poput Si i P koji su korisni za zubne implantate, budući da mogu ubrzati oseointegraciju[6,7].

Postoji razlika među implantatima različitih proizvođača. Implantati se čiste drugačije, tj. svaka kompanija koristi različite metode čišćenja implantata pre nego što ih stavi u prodaju; otuda ima razlika u ceni implantata. Najvažniji je način na koji je implantat očišćen. S obzirom na to da sam implantat ima mnoge nepravilnosti, defekte ili izbočine koje je ponekad veoma teško očistiti, može biti odbačen zbog infekcije periimplantitisa uzrokovane kontaminacijom njegove površine[8].

Zaključak

Kontaminacije zubnih implantata usko su povezane sa neuspehom implantacije. Ukratko, može se zaključiti da zagađivači mogu biti korisni za zubne implantate i/ili imati štetne efekte na njih.

Zahvalnica: Nema**.**

Sukob interesa: Nema**.**

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Contaminants may be beneficial and/or cause adverse effects on dental implants. They can change the surface energy, chemical purity, thickness and composition of the oxide layer. It is also known that the most common elemental contamination of Ti surfaces potentially associated with implant defects are trace elements of N, Ca, P, Cl, S, Na, Si and F, some organic carbons and bacterial cells/ by-products. However, some of the contaminants such as Si and P are beneficial for dental implants that promote osteointegration[6,7].

There is a difference in implants from different manufacturers. All implants are cleaned differently, that is, each company uses different methods of cleaning the implant before it is put on sale. Therefore, there are different prices of implants and the most important thing is the way the implant was cleaned. The implant itself has many irregularities, i.e. depressions, and protrusions that are sometimes very complex to clean, since the implant may break out, infection and peri-implantitis caused by the contamination of the dental implant surface itself may occur[8].

Conclusion

This research is intended for both manufacturers and doctors, which further increases its importance and value. Dental implant contaminations are closely related to implant failures. To summarize, it can be concluded that contaminants may be beneficial and/or cause adverse effects on dental implants.

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PREVALENCIJA LEZIJA ORALNE MUKOZE KOD INSTITUCIONALIZOVANIH STARIJIH OSOBA

PREVALENCE OF ORAL MUCOSAL LESIONS AMONG THE INSTITUTIONALIZED ELDERLY PEOPLE

Mihajlo Petrovski

UNIVERZITET „GOCE DELČEV", FAKULTET MEDICINSKIH NAUKA, ŠTIP, REPUBLIKA SEVERNA MAKEDONIJA

FACULTY OF MEDICAL SCIENCES, GOCE DELCEV UNIVERSITY, STIP, NORTH MACEDONIA

Sažetak

Uvod: *Prisustvo mukoznih promena i varijacija prilično je rasprotranjeno među odraslim osobama u ustanovama.*
Cilj: *Cilj ovog rada bio je da se utvrdi prevalencija promena na oralnoj sluzokoži kod starijih lica smeštenih u ustanove za odrasle osobe.*
Materijal i metode: *Predstavljeni podaci dobijeni su istraživanjem koje je sprovedeno u periodu od maja do jula 2018. godine u staračkom domu „Majka Tereza" u Skoplju, u Republici Severnoj Makedoniji. Istraživanje je obuhvatilo ukupno 70 ispitanika starijih od 65 godina i bilo je usmereno na prisustvo promena na sluzokoži. Prilikom opisa promena na oralnoj sluzokoži koristili smo dva različita pojma – lezija ili patološka promena i varijacija normalne sluzokože.*
Rezultati: *Ispitivanjem prevalencije lezija oralne sluzokože utvrđeno je da svi ispitanici imaju bar jednu oralnu promenu u usnoj duplji. Prosečan broj oralnih promena kod ispitanih starijih osoba u ustanovama bio je 2,24 ± 0,69. Na oralnoj sluzokoži 70 ispitanika dijagnostikovane su ukupno 157 promene. U grupi normalnih varijacija sluzokože dominirali su Status Fordyce (35,71%) i obloženi jezik (28,57%). U grupi patoloških promena preovladavale su lezije povezane sa nošenjem protetičkih sredstava, tj. ulcerozne promene izazvane protetikom (15.71%) i stomatitis protetica (10%).*
Zaključak: *U ispitanoj populaciji potvrđeno je stopostotno prisustvo oralnih promena. Većinu su činile varijacije oralne sluzokože. Međutim, važnije patološke lezije bile su one povezane sa nošenjem protetičkih aparata. Takođe, veoma je važno istaći da patološke lezije zahtevaju stalno praćenje.*

Ključne reči: *institucionalizovane starije osobe, oralne lezije, gerontostomatologija, oralne promene*

Abstract

Background: *The presence of mucosal changes and variations is quite high among institutionalized adults.*
Aim: *The present study aimed to determine the prevalence of oral mucosal changes among the institutionalized elderly.*
Material and method: *The presented data originate from research done in the period from May–July 2018 in "Mother Teresa" nursing home in Skopje, Republic of North Macedonia. The investigation included a total number of 70 subjects older than 65 years and it was focused on the presence of mucosal changes. In describing the changes in oral mucosa we have used two differentiated terms—lesion or pathological change and variation from normal.*
Results: *During the examination of the prevalence of oral mucosal lesions we have found that all the subjects have at least one oral change in their oral cavity. The average number of oral changes among the examined institutionalized elderly is 2,24 ± 0,69. Total number of diagnosed changes on oral mucosa among all 70 subjects was 157. In the group of normal mucosa, variations dominate status fordyce (35.71 %) and coated tongue (28,57%). In the group of pathological changes, there is a domination of the lesions associated with the wearing of prosthetic devices—ulcerous changes caused by the prosthetic devices (15.71%) and stomatitis protetica (10%).*
Conclusion: *In the investigated population, there is a one hundred percent presence of oral changes. Most of them are variations of the oral mucosa. But more important pathological lesions are those associated with wearing prosthetic devices. Also, it is very important to stress that pathological lesions require constant monitoring.*

Key words: *institutionalized elderly, oral lesions, gerontological dentistry, oral changes*

Corresponding author:
Asst. Prof. Mihajlo Petrovski
Faculty of Medical Sciences,
Goce Delčev University , Štip, Republic of North Macedonia
E-mail: mihajlo.petrovski@ugd.edu.mk
Phone:+389 75 288366

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Uvod

Starenje je biološki proces koji ima svoju dinamiku i svoje karakteristike. Ovaj proces je progresivan i nepovratan i odgovoran za modifikaciju strukture i funkcije svih tkiva, uključujući i oralna tkiva.

Poodmaklo doba donosi ozbiljne probleme sa zubima. Hronične bolesti organizma i najčešće oralne bolesti imaju zajedničke faktore rizika. Ovu činjenicu treba imati na umu prvenstveno zbog njihove povezanosti, ali i zbog toga što većina starijih ljudi ima zdravstvene probleme koji mogu uticati na oralno zdravlje.

U pogledu kvaliteta života, oralno zdravlje uslovljavaju mnogi faktori: karijes i njegove komplikacije, koreni zuba koji nisu lečeni i izvađeni, bolesti oralne sluzokože i brojne oralne infekcije, prekancerozna stanja i benigni i maligni tumori, bol u temporo-mandibularnom zglobu, kserostomija i, naravno, totalna ili parcijalna anodoncija[1].

U savremenoj stomatologiji postoji sve veća potreba za rešavanjem svih problema vezanih za oralno zdravlje i higijenu kod starijih. Treba istaći da su razne promene i promene mekih i tvrdih tkiva usne šupljine povezane sa različitim uticajima na oralnu šupljinu, ali i na opšte zdravlje ovih pojedinaca.

Sa starenjem nastaju neizbežne promene u celom organizmu, tako da ni usna duplja ni status zuba nisu pošteđeni.

Prisustvo lezija na sluzokoži kod institucionalizovanih odraslih osoba prilično je rasprostranjeno; najčešće su prisutne lezije oralne sluzokože izazvane nošenjem proteza – protetički stomatitis (*stomatitis protetica*) i protetička hiperplazija. Najčešće promene oralne sluzokože koje nisu povezane sa nošenjem proteza predstavljaju sublingvalne varikoze i prisustvo obloženog jezika[2].

Angularni heilitis (*cheilitis angularis*) koji se razvija kod starijih ljudi ima mešovitu etiologiju i može biti posledica neodgovarajućih međuokluzalnih odnosa ili smanjene sekretorne funkcije pljuvačnih žlezda. Može se manifestovati jednostrano ili bilateralno i najtipičnija je promena kod starijih osoba sa protezama. Starije osobe sa angularnim heilitisom imaju bolove koji se pojačavaju u toku jela, a posebno prilikom skidanja i postavljanja zubnih proteza[3].

Mujica et al.[4] naveli su da je 57% ispitanika imalo jednu ili više oralnih lezija povezanih sa nošenjem zubnih proteza, traumom, odnosno uzrokovanih upotrebom duvana.

Introduction

Ageing is a biological process which has its dynamics and characteristics. This process is progressive and irreversible, and it is responsible for modifying the structure and function of all tissues, including oral tissues.

The advanced age brings serious dental problems. Chronic diseases of the organism and the most common oral diseases present common risk factors. This fact is necessary to know primarily because of their relationship, but also because most elderly people have some health problems that may impact oral health.

Oral health in the context of quality of life is conditioned by many factors such as dental caries and its complications, untreated and non-extracted dental roots, diseases of the oral mucosa and numerous oral infections, precancerous conditions and benign and malignant tumours, pain in the temporomandibular joint, xerostomia and of course the total or partial anodontia[1].

In modern dentistry, there is an increased need to solve all problems associated with oral health and hygiene in the elderly, where various changes and alterations of oral soft and hard tissues are associated with different effects on oral, as well as on the general health of these individuals.

With increasing age, unavoidable changes involve the entire organism, and the oral cavity and dental status are not spared from these changes.

The presence of mucosal lesions among institutionalized adults is quite high and the most frequent lesions of the oral mucosa are those induced by wearing dentures—prosthetic stomatitis (stomatitis protetica) and prosthetic hyperplasia. The most common changes in the oral mucosa that are not associated with wearing dentures are sublingual varices and the presence of a coated tongue[2].

Angular cheilitis (cheilitis angularis) that develops in older people has mixed etiology and may be caused by inappropriate inter-occlusal relations or the reduced secretory function of salivary glands. It can be manifested unilaterally or bilaterally, and it is the most typical change in older persons with prostheses. Older people with angular cheilitis have pain that is aggravated by eating and especially the manipulation of removal and placement of dental prostheses[3].

According to Mujica et al.,[4] 57% of subjects possessed one or more oral lesions associated with the wearing of dental prostheses, trauma or caused by the use of tobacco.

Lezije kod osoba starosti od 60 godina do 74 godine bile su značajno češće kod osoba u ustanovama; pojedini su imali više od četiri oralne lezije. Najčešće zabeležene lezije u ovom istraživanju bile su protetički stomatitis (*stomatitis protetica*), oralna leukoplakija, prisustvo hemangioma, oralne melanotične makule, traumatski fibrom, inflamatorna fibrozna hiperplazija i angularni heilitis (*cheilitis angularis*).

Prema Nevalainenu et al.[5], kod 51% ispitanika sa bimaksilarnom anodoncijom i prisutnim totalnim protezama primećene su oralne promene, dok su kod 31% onih koji imaju mobilne proteze i malo prirodnih zuba uočene promene na sluzokoži. U ovoj studiji, tri najčešće lezije povezane sa nošenjem mobilnih proteza bile su promene u pokrivenosti jezika (atrofični glositis), angularni heilitis (*cheilitis angularis*) i sublingvalne varikoze. Mada je većina lezija benigne prirode, one imaju potencijal da postanu maligne, posebno ako postoje lokalni ili sistemski predisponirajući faktori.

Orofaringealna kandidijaza najčešća je oportuna infekcija usne duplje kod starijih osoba, a uzrokovana je prekomernim rastom gljivica iz *Candida* spp. Najčešće kliničke manifestacije ove bolesti jesu protetički stomatitis, atrofični glositis i akutni angularni heilitis. Prevalencija ove bolesti kod starijih osoba u ustanovama iznosila je između 13% i 47%. Faktori predispozicije za kandidijazu mogu biti lokalni i sistemski. Lokalni faktori uključuju kontinuirano nošenje proteze, smanjeno lučenje pljuvačke i lošu oralnu higijenu[6]. U grupu sistemskih faktora spadaju prekomerna upotreba antibiotika i drugih lekova, neuhranjenost, dijabetes, imuno-supresija i maligniteti. Laurent et al.[7] preporučuju svakodnevno pranje i dezinfekciju proteza i njihovo skidanje noću, naročito kod starijih osoba sa protezama smeštenih u ustanove.

Candida spp. imaju sposobnost da se ugrade u akrilatnu komponentu i ćelije epitela usne šupljine. Prema Ivanovskom et al.[8], ova njihova odlika očigledna je kada se poveća unos ugljenih hidrata i u slučajevima neadekvatne oralne higijene. Kada se uzmu u obzir ova dva lokalna predisponirajuća faktora (smanjene lokalne odbrambene sposobnosti organizma i smanjeno lučenje pljuvačke), što je slučaj kod starijih osoba, mogućnost infekcije kandidijazom mnogo je veća.

Kod starijih ljudi, uprkos povećanom riziku od hroničnih oboljenja u usnoj duplji, uključujući zubne infekcije (kao što su karijes i hronični parodontitis), uprkos velikom broju

Lesions in people aged 60 to 74 years were significantly more common in institutionalized people, and some of them had more than 4 different oral lesions. The most frequently observed lesions according to this research were prosthetic stomatitis (stomatitis protetica), oral leukoplakia (leucoplakia), the presence of hemangioma, oral melanotic macula, traumatic fibroma, inflammatory fibrous hyperplasia and angular cheilitis (cheilitis angularis).

According to Nevalainen et al.,[5] in 51% of the subjects with bimaxillary anodontia and present total dentures, oral changes were noticed, while in 31% of those who own mobile prostheses and few natural teeth, mucosal changes were observed. In this study, the three most common lesions associated with wearing mobile dentures were changes in tongue coverage (atrophic glossitis), angular cheilitis (cheilitis angularis) and sublingual varices. Most of the lesions are benign in nature, but they have the potential to become malignant, especially if there are local or systemic predisposing factors.

Oropharyngeal candidiasis is the most common opportune infection of the oral cavity in the elderly. It is caused by excessive growth of the fungi from *Candida* spp. The most common clinical presentations of this disease are prosthetic stomatitis, atrophic glossitis and acute angular cheilitis. The prevalence of this disease in the institutionalized elderly is from 13% to 47%. Predisposing factors for candidiasis can be local and systemic. Local factors include continuous prosthesis wearing, reduced salivary secretion and poor oral hygiene[6]. The group of systemic factors includes overuse of antibiotics and other drugs, malnutrition, diabetes, immunosuppression and malignancies. Recommendation by Laurent et al.[7] is daily washing and disinfecting dentures and extracting them at night, especially among institutionalized elderly people with prostheses.

Candida spp. can incorporate in the acrylate component and the oral epithelial cells. According to Ivanovski et al.[8] this feature is apparent when intake of carbohydrates is increased and in cases with inadequate oral hygiene. When these two local predisposing factors are noticed—reduced local defence capabilities of the body and reduced secretion of saliva, as is the case in the elderly, the potential for candidiasis infection is much greater.

Older people despite having an increased risk of chronic diseases in the oral cavity,

izvađenih zuba, postoji povećana učestalost benignih lezija sluzokože i raka usne šupljine. Laurent et al.[7] su potvrdili da su najčešće oralne bolesti u starijoj populaciji kserostomija i oralna kandidijaza, obično klinički predstavljene kao pseudomembranozna kandidijaza i eritematozne lezije predstavljene kao protetički stomatitis ili angularni heilitis.

Starenje je kod pojedinih osoba povezano sa smanjenom osetljivosti na ukus. Gubitak čula ukusa ne samo da ukazuje na promenu u kvalitetu života nego dovodi i do gubitka telesne težine i drugih ozbiljnih zdravstvenih problema u institucionalizovanoj odrasloj populaciji[9].

S obzirom na prethodno navedene činjenice o oralnom zdravlju, prisustvo brojnih oralnih tegoba, povećane potrebe i loše oralno zdravlje starijih u ustanovama, cilj ovog rada bio je da se utvrdi prevalencija promena na oralnoj sluzokoži kod institucionalizovanih starijih osoba.

Materijali i metode

Podaci koji se predstavljaju dobijeni su na osnovu pregleda koji su obavljeni u periodu od maja do jula 2018. godine na odeljenju „Majka Tereza“ Gerontološkog instituta „13. novembar“ u Skoplju, u Republici Severnoj Makedoniji.

Istraživanjem je bilo obuhvaćeno ukupno 70 ispitanika starijih od 65 godina. Većinu u ovim ustanovama čine funkcionalno zavisne osobe, a dominiraju hronične bolesti. Ovaj multimorbiditet dovodi do ozbiljnog invaliditeta ili do zavisnosti od pomoći drugih. S druge strane, većini ovih ljudi potrebna je dugotrajna nega.

Sa ciljem objektivne procene stanja oralnog zdravlja kod institucionalizovanih starijih lica, urađen je oralni pregled koji je podrazumevao utvrđivanje prisustva promena na oralnoj sluzokoži. Ispitivanje se odnosilo na prisustvo mukoznih promena i njihovu povezanost sa postojećim protetičkim aparatima.

Prilikom opisa promena na oralnoj sluzokoži koristili smo dva različita pojma:

- lezija ili patološka promena;
- varijacija normalnog.

Ako je promena uzrokovana specifičnim i određenim patološkim procesom specifične etiologije, ako je potrebno lečenje i ako se ne leči i ima lošu prognozu, lezija se označava kao oralna lezija. Promene bez kliničkih pojava koje ne zahtevaju lečenje svrstavaju se u grupu varijacija normalne oralne sluzokože.

including dental infections (such as caries and chronic periodontitis), and a high number of extracted teeth, have an increased incidence of benign mucosal lesions and oral cancer. Laurent et al.[7] confirmed that the most common oral diseases among the elderly are xerostomia and oral candidiasis, commonly clinically presented as pseudo-membranous candidiasis, erythematous lesions presented as prosthetic stomatitis or angular cheilitis.

Ageing in some older individuals is associated with reduced sensitivity to taste. The loss of sense of taste indicates not only on the changes the quality of life, but also leads to loss of weight and other serious health problems in the institutionalized adult population[9].

Taking into consideration previously mentioned facts about oral health, the presence of numerous oral problems and increased needs and poor oral health among the institutionalized elderly, the aim of this paper was established—to determine the prevalence of oral mucosal changes among the institutionalized elderly.

Material and method

The presented data originate from research done in the period from May to July 2018 in the department “Mother Teresa", within the Gerontology Institute "13th November" Skopje, Republic of North Macedonia.

The investigation included a total number of 70 subjects older than 65 years. In these institutions, most institutionalized persons are functionally dependent individuals, and chronic diseases are dominant. This multimorbidity leads to serious disability or dependence on foreign assistance, and on the other hand, most of these people need long-term care.

To make an objective assessment of the situation of oral health in the institutionalized elderly, adequate clinical examination was performed—an oral examination that included a determination of the presence of oral-mucosal changes. The survey refers to the presence of mucosal changes, and their linkages with existing prosthetic devices.

In describing the changes in oral mucosa, we have used two differentiated terms-

- lesion or pathological change, and
- variation of normal.

If a change is caused by a specific and definite pathologic process with a specific etiology, requires treatment, and has a poor prognosis if left untreated, the lesion is

Promene na oralnoj sluzokoži takođe su podeljene na osnovu njihovog odnosa prema nošenju protetičkih sredstava. Lezije se mogu smatrati povezanim sa nošenjem proteza samo ako su lokalizovane na oralnoj sluzokoži ispod baze proteze i ako ne postoji drugo objašnjenje za njihov poseban izgled ispod baze proteze.

Dijagnoza oralnosluzokožne promene zasnivala se samo na vizuelnom pregledu ili na parakliničkim testovima. Biopsija nije bila korišćena kao dijagnostička procedura.

Podaci dobijeni na osnovu anamneze i kliničkog pregleda bili su prikupljeni i statistički obrađeni u skladu sa tim.

Za statističku obradu koristili smo poseban softver za statističku obradu podataka – *Statistica* 7.1.

Rezultati su predstavljeni u tabelama i grafikonima.

Rezultati

Prilikom ispitivanja rasprostranjenosti lezija oralne sluzokože i drugih stanja, utvrdili smo da svi ispitanici imaju bar jednu oralnu promenu u usnoj duplji. Kod približno polovine ispitanika uočeno je prisustvo dveju promena na oralnoj sluzokoži (47.14 % ispitanika). Prosečan broj oralnih promena kod ispitanih starijih osoba u ustanovama bio je 2,24 ± 0,69.

Na oralnoj sluzokoži 70 ispitanika dijagnostikovane su ukupno 157 promene.

Oralne promene su podeljene u dve velike grupe: varijacije oralne sluzokože i patološke promene oralne sluzokože. Kod starijih osoba u ustanovama preovladavale su varijacije normalne sluzokože (Slika 1).

classified as an oral lesion. Changes without clinical expression that do not require treatment are classified as variations from normal oral mucosa.

Changes in the oral mucosa are also divided according to their relation to the wearing prosthetic devices. They are considered to be related to denture wearing only if they are localized in the oral mucosa under prosthetic base and if there is no other explanation for their particular appearance under the denture base.

The diagnosis of oral-mucosal change is based only on visual inspection or paraclinical diagnostic tests, but biopsy as a diagnostic procedure was not used.

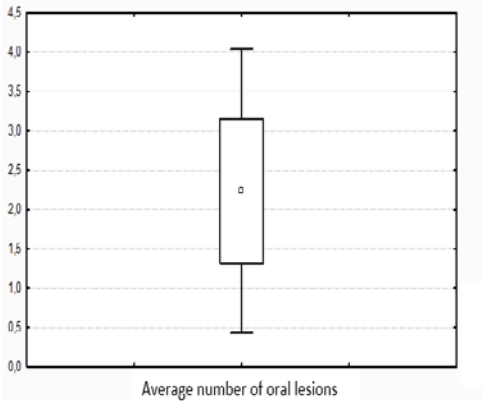
The data obtained from the history and clinical examination were statistically processed using special software Statistica 7.1 for statistical data processing. Results are presented using tables and figures.

Results

During the research on the prevalence of oral mucosal lesions and other conditions, it was found that all the subjects had at least one oral change in their oral cavity. In approximately half of the subjects, the presence of two changes in the oral mucosa (47.14% of the subjects) was observed. The average number of oral changes among the examined institutionalized elderly was 2,24 ± 0,69.

Total number of diagnosed changes in oral mucosa among all 70 subjects was 157.

Oral changes were divided into two major groups: variations of the oral mucosa and pathological changes of the oral mucosa. In the institutionalized elderly more prevalent were variations of the normal mucosa (Figure 1).



Slika 1. Prosečan broj lezija oralne mukoze kod starijih osoba
Figure 1. Average number of oral-mucosal lesions in the elderly

Najčešće su bile prisutne promene povezane sa dugotrajnom upotrebom proteza ili protetičkih sredstava neodgovarajućih dimenzija (67.50% ispitanika koji nose proteze žali se na izvesne poteškoće prilikom nošenja). Najmanje je bilo potvrda aftoznih promena i hemangioma (5.71% i 2.86%, redom).

Kod ispitanih starijih osoba zabeleženo je više od dvadeset različitih promena oralne sluzokože. Najčešće oralne promene bile su: *Status Fordyce* (35.71%), obložen jezik (28.57%), sublingvalne varikoze (20.00%), *lingua plicata* (20.00%), angularni heilitis (17.14%), pigmentacija oralne sluzokože (17.14%), atrofične promene jezičnog obuhvata (12.86%), dekubitalne ulcerozne promene oralne sluzokože (15.71%), protetička ili traumatska hiperplazija (8.57%) i *stomatitis protetica* (10.00%) (Tabela 1).

U grupi normalnih varijacija sluzokože dominirali su *Status Fordyce* (35.71%) i obloženi jezik (28.57%).

U grupi patoloških promena preovladavale su lezije povezane sa nošenjem protetičkih sredstava – dekubitalno-ulcerozne promene izazvane nošenjem protetičkih sredstava (15.71%) i *stomatitis protetica* (10%). Od preostalih pomenutih promena najčešće su bile atrofija jezične pokrivenosti (12.86%) i aftozna promena (5.71%).

Kod jednog (1.43%) ispitanika konstatovano je prisustvo pareze n. *facialis*. Osim pareze, kod ovog pacijenta otkriveni su Status Fordyce, obloženi jezik i angularni heilitis.

Most commonly present changes associated with long-term use of prostheses or inadequately dimensioned prosthetic devices (67.50% of subjects who wore prostheses complained of some difficulty wearing them), while having aphthous changes and haemangiomas (5.71% and 2.86%, respectively).

More than twenty different changes of the oral mucosa were found among the surveyed elderly. Most common oral change were: Status fordyce (35.71%), coated tongue (28.57%), sublingual varices (20.00%), lingua plicata (17.14 %), angular cheilitis (20.00%), pigmentation of the oral mucosa (17.14%), atrophic changes of tongue coverage (12.86%), and decubital ulcerous changes of oral mucosa (15.71%), prosthetic or traumatic hyperplasia (8.57%) and stomatitis protetica (10.00%) (Table 1).

In the group of normal mucosa variations dominated status fordyce (35.71%) and coated tongue (28.57%).

In the group of pathological changes dominated the lesions associated with wearing prosthetic devices—decubital-ulcerous changes caused by the wearing of prosthetic devices (15.71 %) and stomatitis protetica (10%), while from the remaining changes most frequent were atrophy of tongue coverage (12.86 %) and aphthous change (15.71%).

In one (1.43%) of the subjects, the presence of paresis of n. facialis was noted. Apart from paresis, status fordyce, coated tongue and angular cheilitis were detected in this patient as well.

Tabela 1. Prevalencija promena oralne mukoze kod starijih osoba smeštenih u institucijama

Table 1. Prevalence of oral mucosal alterations among the institutionalized elderly

Oral mucosa alterations	No.	Percentage of examined population	Percentage of the total number of lesions
Lesions			
➢ *Angular cheilitis*	12	17.14 %	7.64 %
➢ *Decubital ulcers*	11	15.71 %	7.01 %
➢ *Atrophic glossitis*	9	12.86 %	5.73 %
➢ *Traumatic hyperkeratosis*	8	11.43 %	5.09 %
➢ *Stomatitis protetica*	7	10.00%	4.46 %
➢ *Prosthetic hyperplasia*	6	8.57 %	3.82 %

➢ *Aphtous changes*	4	5.71 %	2.55 %
➢ *Herpes labialis*	2	2.86 %	1.27 %
➢ *Hemanghioma*	2	2.86 %	1.27 %
➢ *Lichen planus*	1	1.43 %	0.64 %
Total	62		
Variations			
➢ *Status Fordyce*	25	35.71%	15.92 %
➢ *Coated tongue*	20	28.57 %	12.74 %
➢ *Sublingual varices*	14	20.00%	8.92 %
➢ *Lingua plicata*	14	20.00 %	8.92 %
➢ *Oral pigmentations*	12	17.14 %	7.64 %
➢ *Torus palatinus*	4	5.71 %	2.55 %
➢ *Hyperplasio gll. labiorum*	4	5.71 %	2.55 %
➢ *Lingua geographica*	3	4.29 %	1.91 %
➢ *Short lingual frenulum*	1	1.43 %	0.64 %
Total	95		100.00 %

Diskusija

Podaci o prisustvu oralnih promena kod starijih osoba u ustanovama do kojih se došlo u ovom istraživanju ukazuju na to da je stanje lošije od onog posvedočenog u brojnim studijama koje su se sprovodile u visokorazvijenim zemljama.

Stopostotno prisustvo oralnih promena među starijim osobama u ustanovama obuhvaćenim našom studijom veće je od prevalencije koju su prikazali Kal Dundar i Turska (40,7%)[10], Rabiei et al. (86,1%)[11] i Ekelund (60%)[12]. Ipak, treba pomenuti da poređenje podataka dobijenih u ovoj studiji sa podacima iz drugih epidemioloških studija nije adekvatno, kako zbog varijacija u metodologiji i klasifikaciji promena, tako i zbog razlika u dijagnostičkim kriterijumima. Smatra se da je ovako visoka učestalost oralnih promena posledica činjenice da se ne pravi razlika između striktno patoloških i nepatoloških lezija.

Discussion

The presence of oral changes in the institutionalized elderly found in this research is worse in comparison with the data presented in numerous studies in highly developed countries.

A one hundred percent presence of oral changes among the institutionalized elderly in this study is higher than the prevalence presented by Kal Dundar and Turkey[10] (40.7%), Rabiei et al.[11] (86.1%) and Ekelund[12] (60%). A comparison of the data obtained in this study and from other epidemiological studies is inadequate primarily because of the variations in methodology and classification changes as well as differences in diagnostic criteria. This high incidence of oral changes are thought to be due to the fact that no distinction is made on strictly pathological and non-pathological lesions.

Na primer, prisustvo oralnih lezija kod starijih osoba u ustanovama u Danskoj iznosilo je 45% zato što su se procenjivale samo lezije lokalizovane na jeziku[13].

Minimalna prevalencija od 18,3% oralnih lezija koju su naveli Saintrain et al.[14] pokazuje koliko je značajan uticaj metodologije i različitih kliničkih dijagnostičkih kriterijuma za procenu njihove prevalencije.

Više od polovine naših ispitanika, tačnije 60.51% njih (Tabela 1), imalo je promene sluzokože koje su registrovane kao varijacije normalne oralne sluzokože; one su benigne i ne zahtevaju poseban tretman. Ovaj rezultat se u potpunosti poklapa sa onim do kojeg su došli Ferreira et al.[2]. Smatra se da su promene uglavnom posledica procesa adaptiranja oralnog tkiva na dejstvo mehaničkih, hemijskih ili termičkih faktora. U manjem broju slučajeva, lezije su uzrokovane sistemskim oboljenjima ili imaju premaligni karakter[15].

Prema našem mišljenju, visoka zastupljenost obloženog jezika od 28.57% (Tabela 1) u ispitivanoj populaciji rezultat je neadekvatne oralne higijene ispitanika, njihove nepravilne ishrane, a može biti i nuspojava korišćenih lekova. Ova varijacija usne duplje izdvaja se kao najčešća među starijim osobama smeštenim u ustanove u brojnim radovima[16-18]. Slične rezultate predstavili su i Ferreira et al.[2] i Smith et al.[19]. Rezultati do kojih su došli Avcu et al.[20], Samaranaiake et al.[18] i Campisi i Margiota[21] ukazali su na prisustvo obloženog jezika kod više od polovine ispitanika. Solemdal et al.[22] i Lavahez et al.[23] pomenuli su ređe prisustvo obloženog jezika kod starijih osoba smeštenih u ustanove (ispod 10%).

Kada je posredi *Status Fordyce*, rezultati do kojih se došlo u ovoj studiji (35.71%) (Tabela 1) slični su onima koje su dobili Ferreira et al.[2]; Olivier[24] pak prikazuje skoro dvostruku prevalenciju – 52,7%.

Prisustvo *lingua plicata* varira u različitim studijama i ispitivanjima. Podaci koje su izneli Jainkittivong et al.[25,26] i Rabiei et al.11 slični su podacima o prisustvu *lingua plicata* iz ovog istraživanja – 20% (Tabela 1). Mozafari et al.[27] primetili su veću prevalenciju *lingua plicata* (66,5%) nego Triantos[28], Lavahez et al.[23] i Mallo et al.[29], koji su naveli nižu prevalenciju varijacija sluzokože.

Sublingvalne varikoze su veoma česte varijacije sluzokože kod starijih osoba[25,30-32]. U različitim studijama predstavljen je širok spektar podataka. Rabei et al.[11] dali su prezentaciju sublingvalnih varikoziteta sličnu onoj iz ovog istraživanja: 20.00% (Tabela 1).

For example, the presence of oral lesions in 45% of the institutionalized elderly in Denmark is because only mucosal lesions localized on the tongue were evaluated[13].

Minimal prevalence of 18.3% of oral lesions detected by Saintrain et al.[14] indicates a significant impact of the methodology and the different clinical diagnostic criteria for the evaluation of their prevalence.

More than half, precisely 60.51% of the subjects possess mucosal alterations registered as variations of normal oral mucosa, which are benign and do not require special treatment (Table 1). This finding fully coincides with that of Ferreira et al.[2] It is thought that the changes are mainly due to adaptive processes of the oral tissues to the action of mechanical, chemical or thermal factors, while fewer lesions are caused by systemic diseases or have premalignant character[15].

The high presence of 28.57% of coated tongue in the examined population is believed to be the result of inadequate oral hygiene among subjects, improper diet or may be a side effect of used medications (Table 1). In numerous studies, this variation of the oral cavity is considered as most common among the institutionalized elderly[16-18]. Similar results in their articles were published by Ferreira et al.[2] and Smith et al.[19] Findings presented by Avcu et al.[20] Samaranayake et al.[18] and Campisi and Margiota[21] indicate the presence of coated tongue in more than half of the subjects. Solemdal et al.[22] and Lawahez et al.[23] presented a smaller presence of coated tongue among the institutionalized elderly (below 10%).

The presence of 35.71% of Status Fordyce shown in this study (Table 1) is similar to the prevalence found by Ferreira et al.[2] while Olivier[24] suggests almost double prevalence—52.7%.

The presence of lingua plicata varies in different studies. The data presented by Jainkittivong et al.[25,26] and Rabiei et al.[11] are similar to the data relating to the presence of lingua plicata discovered in this research—20% (Table 1). Mozafari et al.[27] noted a higher prevalence of lingua plicata (66.5%), versus Triantos[28], Lawahez et al.[23] and Mallo et al.[29] who presented a lower prevalence of this mucosal variation.

Sublingual varices are very common mucosal variations in the elderly[25,30-32]. Rabei et al.[11] presented a similar representation of sublingual varices as in this study-20.00% (Table 1) vs. Mozafari et al.[27] and Ferreira et al.[2] who presented prevalence of this alteration more than 50%.

S druge strane, Mozafari et al.[27] i Ferreira et al.[2] ukazali su na to da prevalencija ove promene iznosi više od 50%. Ieatts i Burns[33] i Jainkittivong et al.[25] pomenuli su prevalenciju sublingvalnih varikoziteta manju od 5%.

Torus palatinus je egzostoza koja može biti različito izražena, sa različitim oblicima i konfiguracijom[34]. U ovom istraživanju je kod 5.71 % (Tabela 1) ispitanika registrovana egzostosa – *torus palatinus*. Na sličnu prevalenciju ovih egzostoza ukazali su Kurniavan et al.[35]. Rezultati do kojih su došli Mumcu et al.[36] pokazali su da je prevalencija *torus palatinus* manja od jednog procenta (0,5%). Nasuprot ovim studijama, istraživanja mnogih drugih autora predočila su značajno veću prevalenciju navedenih egzostoza[33,37-39].

Lingua geographica se klinički manifestuje sa atrofičnim jako eritematoznim delovima dorzalne površine jezika sa nepravilnim ivicama. Prevalencija ove varijacije oralne sluzokože od 4.29% (Tabela 1) među našim ispitanicama slična je prevalenciji koju su naveli Mansoir-Chanaei et al.[40] i Robledo-Sierra et al.[41], a razlikuje se od one koju su pomenuli Iarom et al.[42] – prevalencija ove promene sluzokože u toj studiji bila je veća. Da je učestalost ove varijacije sluzokože niska pokazala su i istraživanja koja su sproveli Ferreira et al.[2], Mozafari et al.[27] i Shulman i Carpenter[43]. Shulman i Carpenter[43] i Taivo et al.[44] su u svojim studijama istakli snažnu povezanost benignog migratornog glositisa i *lingua plicata*.

Lingvalni frenulum kao jaka fibrozna traka koja povezuje jezik sa podom usne duplje kod anodontskih pacijenata može uticati na adekvatnu stabilnost donje proteze. Rezultati koji se tiču prisustva nepravilno postavljenog frenuluma u našem istraživanju iznosili su 1,43% (Tabela 1); to se poklapa sa nalazima Lalakea i Messnera[45] i Mujice et al.[4]. Kueiroz Marchesan[46] pomenuo je veću prevalenciju nepravilno postavljenog jezičnog frenuluma (od 9%) kod starijih osoba.

Protetički stomatitis i protetička hiperplazija najčešće su lezije oralne sluzokože koje su povezane sa nošenjem protetičkih sredstava. Hiperplazija proteze bila je prisutna kod 10% naših ispitanika (Tabela 1). Rezultati ovog istraživanja slični su nalazima Mozafarija et al.[27] i Mujice et al.[4].

Pojedini autori smatraju da se stariji navikavaju na protezu koja je preopterećena. Međutim, ovakve neadekvatne proteze mogu dovesti do pojave oralnih lezija[47].

Yeatts and Burns[33], and Jainkittivong et al.[25] published a prevalence of sublingual varices of less than 5%.

Torus palatinus is an exostosis which may be expressed differently with different shape and configuration[34]. In this study, 5.71 % of subjects had registered exostoses—tori palatini (Table 1). A similar prevalence of such exostoses was presented by Kurniawan et al.[35] while Mumcu et al.[36] presented a prevalence of torus palatinus under one percent (0.5%). In contrast to these studies, numerous other authors present a significantly higher prevalence of these exostoses in their studies[33,37–39].

Lingua geographica is clinically presented with atrophic strongly erythematous areas of the dorsal surface of the tongue with irregular borders. The prevalence of this variation of the oral mucosa among the institutionalized persons presented in this study—4.29% (Table 1) is similar to the prevalence presented by Mansoir-Chanaei et al.[40] and Robledo-Sierra et al.,[41] unlike Yarom et al.[42] who showed higher prevalence of this mucosal alteration. The low frequency of this variation of mucosa is presented by Ferreira et al.[2], Mozafari et al.[27] and Shulman and Carpenter[43]. Shulman and Carpenter[43] and Taiwo et al.[44] in their study presented a strong association of benign migratory glossitis and lingua plicata.

The lingual frenulum as strong fibrous band that connects the tongue to the floor of the oral cavity among enodontic patients can affect the stability of the lower prosthesis. The results obtained in this study, about the presence of improperly positioned frenulum, is 1.43% (Table 1) and coincide with the findings presented by Lalakea and Messner[45] and Mujica et al.[4] Queiroz Marchesan[46] presents a higher prevalence of improperly positioned lingual frenulum in 9% of the elderly.

Stomatitis protetica and prosthetic hyperplasia are the most common lesions of the oral mucosa associated with wearing prosthetic devices. Prosthetic hyperplasia was presented in 10% of these subjects (Table 1). These results are similar to the findings of Mozafari et al.[27] and Mujica et al.[4]

Some authors believe that the elderly get used to to-extent prosthesis. Such inadequate dentures can lead to the occurrence of oral lesions[47]. High number of lesions associated with wearing prosthetic devices in most cases, except for instability of dentures, is due to inadequate oral hygiene and irregular dental check-ups[48].

Velik broj lezija povezanih sa nošenjem protetičkih sredstava uglavnom nastaje (osim prilikom nestabilnosti proteza) usled neadekvatne oralne higijene i neredovnih stomatoloških pregleda[48].

Stomatitis protetica predstavlja kliničku dijagnozu koja opisuje zapaljenjsko stanje oralnog tkiva koje je povezano sa nošenjem mobilnih protetičkih sredstava. Klinički se manifestuje prisustvom mesta eritema u kontaktu sa bazom proteze, erozija i čireva, te prisustvom otoka i bolova. Premda brojni faktori mogu izazvati ovo stanje, pojedini autori ukazuju na to da dominantnu ulogu imaju loša oralna higijena[49], *Candida* spp.[50,51] i neodgovarajuća dimenzija protetičkih sredstava[52]. Incidencija *stomatitis protetica* potvrđena u Sjedinjenim Američkim Državama iznosi 21%; oko 40% starijih osoba u ustanovama u Danskoj imalo je izvesne poteškoće da se lokalizuje pod protetičkim aparatima. Smatra se da se protetički stomatitis javlja kod otprilike jedne trećine starijih osoba u ustanovama koje nose protetička sredstva[53]. Prevalencija protetičkog stomatitisa od 10.00% (Tabela 1) zabeležena u ovom istraživanju manja je od prevalencije koja je prikazana u drugim studijama i iznosi više od 15%[54,55]. Veruje se da je ovako slabo prisustvo protetičkog stomatitisa povezano sa slabim prisustvom protetičkih uređaja testiranih kod starijih osoba.

Smatra se da je hiperplazija proteze posledica proširenih krila i ivica proteze, ali i odsustva bliskog kontakta između baze proteze i oralnog tkiva ispod[48,56]. Ferreira et al.[2], Baran i Nalcaci[57] i Jorge Junior J. et al.[58] uočili su prisustvo hiperplazije veće od onog u našem istraživanju – 8.57 % (Tabela 1). Podaci o prisustvu protetičke hiperplazije koje su prezentovali Mujica et al.[4] i Corbet et al.[59] slični su podacima do kojih se u ovom istraživanju došlo. Jainkittivong et al.[25] i Ferreira et al.[2] ukazali su na prisustvo traumatskih ulkusa slično onom iz naše studije – 15.71% (Tabela 1). Baran i Nalcaci[60] i Moskona i Kaplan[61] pokazali su pak da su traumatski ulkusi u većoj meri prisutni kod starijih osoba u ustanovama. Mujica et al.[4], Mozafari et al.[27], Espinosa et al.[62] i Garcia-Pola Vallejo et al.[63] pomenuli su manju prevalenciju traumatskih ulceracija uzrokovanih nošenjem protetičkih aparata.

Prema mišljenju mnogih autora, angularni heilitis povezan je sa problemima temporomandibularnog zgloba[64], protetičkim stomatitisom[48,64] ili inflamatornom fibroznom hiperplazijom[48]. Prevalencija angularnog heilitisa predstavljena u radovima čiji su autori Thomson et al.[65] i Nimri et al.[66] slična je prevalenciji angularnog heilitisa na koju je

Stomatits protetica is a clinical diagnosis that describes an inflammatory condition of oral tissues associated with wearing mobile prosthetic devices. Clinically it is manifested by the presence of erythema which is in contact with the prosthetic base, erosions and ulcers, and the presence of swelling and pain. Numerous factors can cause this condition, some authors indicate that the predominant role plays poor oral hygiene[49], *Candida* spp.,[50,51] and inadequate dimension of the prosthetic device[52]. Incidence of stomatitis protetica present in the United States of America is 21%, and about 40% of the institutionalized elderly in Denmark have some difficulty located under prosthetic devices. It is believed that stomatitis protetica occurs in approximately one third of the institutionalized elderly who wear prosthetic devices[53]. The prevalence of prosthetic stomatitis of 10.00% (Table 1) registered in this research is less than the prevalence of stomatitis that is presented in other studies and is over 15%[54,55]. It is considered that this low prevalence of prosthetic stomatitis is due to the low number of prosthetic devices tested in the elderly.

Prosthetic hyperplasia is a consequence of extended prosthetic wings and edges, but also occurs due to the absence of close contact between the prosthesis base and oral tissue underneath[48,56]. Ferreira et al.,[2] Baran and Nalcaci[57] and Jorge Júnior J et al.[58] observed a higher presence of this hyperplasia, compared with this survey—8.57% (Table 1). Similar to these results, data about the presence of prosthetic hyperplasia registered by Mujica et al.[4] and Corbet et al.,[59] Jainkittivong et al.[25] and Ferreira et al.[2] demonstrated the presence of traumatic ulcers similar to those obtained in this study—15.71% (Table 1). Baran and Nalçaci[60] and Moskona and Kaplan[61] indicated a higher presence of traumatic ulcers in institutionalized elderly. Mujica et al.,[4] Mozafari et al.[27] Espinosa et al.[62] and Garcia-Pola Vallejo et al.[63] published a smaller prevalence of traumatic ulceration caused by wearing prosthetic devices.

According to many authors, angular cheilitis is associated with problems of temporomandibular joint[64], prosthetic stomatitis[48,64] or inflammatory fibrous hyperplasia[48]. Thomson et al.[65] and Nimri et al.[66] presented the prevalence of angular cheilitis, similar to the prevalence of angular cheilitis in this study (Table 1). Smaller prevalence of angular cheilitis is presented by Mujica et al.,[4] King and Kapadia[67] and Jorge Júnior J. et al.[67] In contrast, higher prevalence of angular cheilitis is noted by Samaranayake et al.[18] and Peltola et al.[68] in their research.

naše ispitivanje ukazalo (Tabela 1). Mnogo manje prisustvo angularnog heilitisa pomenuli su Mujica et al.[4], King i Kapadia[67] i Jorge Junior J. et al.[58]. Nasuprot tome, Samaranaiake et al.[18] i Peltola et al.[68] zapazili su veću prevalenciju angularnog heilitisa.

Atrofične promene dorzalnog jezika česte su promene na leđnoj površini jezika kod starijih osoba. Naše istraživanje je pokazalo da su ove promene prisutne kod 12.86% (Tabela 1) starijih osoba smeštenih u ustanove, što je u skladu sa rezultatima koje su dobili Thomson et al.[65], Kurniavan et al.[35], Mozafari et al.[27] i Sveeni et al.[69]. Ferreira et al.[2] i Triantos[28] ukazali su pak na manju prevalenciju atrofičnih promena na jeziku kod starijih osoba u ustanovama.

Rekurentni aftozni stomatitis veoma je česta bolest među različitim rasnim i etničkim populacijama i može se manifestovati u različitim periodima života. Reč je o bolesti nepoznate etiologije. Prevalencija aftoznih promena u ovoj studiji iznosila je 5.71% (Tabela 1), što je vrednost niža od one dobijene u studiji koju su sproveli Dandgore-Khasbage et al. (19,33%)[70]. Brojne druge studije otkrile su značajno manju zastupljenost rekurentnog aftoznog stomatitisa kod starijih osoba u ustanovama[2,4,63,71,72].

Od 80% do 90% stanovništva imalo je bar jednu epizodu rekurentnog labijalnog herpesa do pedesete godine života[73]. Zbog oslabljenog imuniteta, pojava ove bolesti retka je kod starijih osoba. Prisustvo rekurentnog labijalnog herpesa među našim ispitanicima (2.86% (Tabela 1)) bilo je veće nego u drugim objavljenim rezultatima[2,4,27].

Hemangiomi u usnoj duplji nisu toliko česti. Ipak, kada se vrši poređenje sa drugim mestima, primećuje se da su glava i vrat mesta na kojima se hemangiomi najčešće pojavljuju. Otprilike od 10% do 20% hemangioma postaje vidljivo kasnije u toku života[74]. Prisustvo hemangioma među ispitanicima u ovoj studiji iznosilo je 2.86% (Tabela 1), što se poklapa sa rezultatima do kojih su došli Garcia-Pola Vallejo et al.[63] i Triantos[28]. Mujica et al.[4] zabeležili su veću prevalenciju ove vaskularne malformacije, dok je u jednoj publikaciji Mozafarija et al.[27] predstavljen manji prikaz ovog benignog stanja.

Lichen planus je relativno česta bolest usne šupljine i kože, koja uglavnom pogađa od 0,5% do 2,0% opšte populacije[75]. Rezultati naše studije ukazali su na to da je pomenuta oralna promena u ovoj specifičnoj populaciji bila prisutna u 1,43% slučajeva (Tabela 1),

Atrophic change in the dorsum linguae is quite frequent change on the dorsal surface of the tongue in the elderly. According to this research, these changes are present in 12.86% (Table 1) of the institutionalized elderly and are consistent with the findings of Thomson et al.[65] and Kurniawan et al.[35] Significantly higher prevalence of atrophic change in the tongue is found by Mozafari et al.[27] and Sweeny et al.[69] Ferreira et al.[2] and Triantos(28) are indicating smaller prevalence of atrophic changes on the tongue among the institutionalized elderly.

Recurrent aphthous stomatitis is a very common disease among different racial and ethnic populations and can manifest in various ages. This is a disease with unknown aetiology. Revealed prevalence of aphthous changes in this study was 5.71% (Table 1). This value is lower than the presented in one study by Dandgore-Khasbage et al.70 (19.33%). Numerous other studies have found significantly lower representation of recurrent aphthous stomatitis in institutionalized elderly[2,4,63,71,72].

Until the fiftieth year of life, 80−90% of the population have experienced at least one episode of recurrent labial herpes[73]. Due to reduced immunity, in older persons there is a rare occurrence of this disease. In this study, the presence of recurrent labial herpes of 2.86% (Table 1) is higher compared to other published results[2,4,27].

Hemangiomas in the oral cavity are not that common, but if a comparison is made with other body sites, the head and neck are the places where hemangiomas usually appear. Approximately 10 to 20% of hemangiomas become visible later in life[74]. The presence of hemangiomas described in this study is 2.86% (Table 1), which coincides with the results of Garcia-Pola Vallejo et al.[63] and Triantos[28]. Mujica et al.[4] indicate a higher prevalence of this vascular malformation, unlike one publication of Mozafari et al.[27] where is presented smaller representation of this benign condition.

Lichen planus is a relatively common oral and skin disease, generally affecting 0.5 to 2.0% of the general population[75]. The results presented in this study indicate that the presence of this oral change in this specific population is 1.43% (Table 1), and they coincide with both the prevalence of the disease in the general population, and the results presented by Mozafari et al. for the institutionalized elderly[27].

što nije u skladu samo sa prevalencijom bolesti u opštoj populaciji već i sa rezultatima koje su dobili Mozafari et al. u grupi starijih osoba u ustanovama[4]. Veću prevalenciju primetili su i Mujika et al.[27] i Garcia-Pola Vallejo et al.[63]. S druge strane, istraživanje koje su sproveli Ferreira et al.[2] pokazalo je manju prevalenciju ove oralne bolesti.

Visoka prevalencija oralnih lezija jedan je od glavnih razloga za preporuku sistematskih stomatoloških pregleda starijih osoba koje borave u ustanovama. Lezije koje imaju moguću malignu transformaciju izuzetno su važne, baš kao i njihova rana dijagnoza i adekvatno lečenje. Od naročitog je značaja kontinuirano praćenje registrovanih lezija oralne sluzokože sa malignim potencijalom, kao što su *lichen planus*, traumatski ulkusi i hiperplazija.

Iako su i navedene varijacije oralne sluzokože česte u usnoj duplji, najčešće patološke promene registrovane kod naših ispitanika bile su one povezane sa nošenjem proteza. Glazar et al.[76] i Evren et al.[77] primetili su da starije osobe smeštene u ustanove imaju značajno više mukoznih promena od starijih osoba koje nisu u ustanovama.

Zaključak

U ispitivanoj populaciji posvedočeno je stopostotno prisustvo oralnih promena. U većini slučajeva reč je bila o varijacijama oralne sluzokože. Međutim, najvažnije patološke lezije bile su promene povezane sa nošenjem protetičkih sredstava. Takođe, veoma je važno naglastiti da patološke lezije zahtevaju stalno praćenje.

Higher prevalence is noticed by Mujica et al.[4] and Garcia-Pola Vallejo et al.[63] unlike Ferreira et al.[2] who showed a smaller prevalence of this oral disease.

The high prevalence of oral lesions is one of the main reasons for recommending systematic dental examination of the institutionalized elderly. Lesions that have possible malignant transformation are extremely important, and their early diagnosis and adequate treatment are very important. What is especially important is the continuous monitoring of registered oral mucosa lesions with malignant potential such as lichen planus, traumatic ulcers and hyperplasia.

Even though variations of the oral mucosa are more common in the oral cavity, the most common pathological changes which are registered among these subjects are associated with wearing prostheses. Glazar et al.[76] and Evren et al.[77] noted that the institutionalized elderly have significantly more mucosal changes in comparison with the non-institutionalized elderly.

Conclusion

In the investigated population, we have a one hundred percent presence of oral changes. Most of them are variations of the oral mucosa. But the most important pathological lesions are the changes associated with wearing prosthetic devices. Also, it is very important to stress that pathological lesions require constant monitoring.

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FOTOGRAMETRIJSKI PARAMETRI LICA KAO POKAZATELJI LEPOTE

FACIAL PHOTOGRAMMETRIC MEASUREMENTS AS BEAUTY LANDMARKS

Gordana Lj. Filipović[1], Dušan R. Radmanović[2], Nikola M. Stojanović[3]

[1]UNIVERZITET U NIŠU, MEDICINSKI FAKULTET, KATEDRA ZA ORTOPEDIJU VILICA, NIŠ, SRBIJA
[2]UNIVERZITET U NIŠU, MEDICINSKI FAKULTET, NIŠ, SRBIJA
[3]UNIVERZITET U NIŠU, MEDICINSKI FAKULTET, KATEDRA ZA FIZIOLOGIJU, NIŠ, SRBIJA

[1]UNIVERSITY OF NIŠ, FACULTY OF MEDICINE, DEPARTMENT OF ORTHODONTICS,
[2]UNIVERSITY OF NIŠ, FACULTY OF MEDICINE,
[3]UNIVERSITY OF NIŠ, FACULTY OF MEDICINE, DEPARTMENT OF PHYSIOLOGY

Sažetak

Uvod: *Lepota i atraktivnost ljudskih karakteristika lica veoma su subjektivne i na njih mogu uticati mnogi faktori – kulturološki, društveni i lični faktori, na primer. Zahvaljujući kompleksnim neuronskim mehanizmima, omogućeno nam je da opažamo sve, kao i da odlučimo da li nešto smatramo atraktivnim ili ne. Najčešći i najznačajniji faktori povezani sa dobrom estetikom lica jesu simetrija i proporcije lica. Važno je pomenuti da one mogu biti detaljno analizirane pomoću fotogrametrije, neinvazivne tehnike koja koristi fotografije ili 3D metode snimanja da zabeleži i analizira kraniofacijalne strukture i karakteristike, u svrhe dijagnostike, planiranja tretmana, monitoringa, ali i istraživanja. Parametri od velikog značaja u fotogramteriji jesu angularni parametri – takvi su nazofrontalni ugao, nazolabijalni ugao, mentolabijalni ugao i ugao profila lica – i linearni parametri: odnos širine i visine lica, širina nosa, distanca između očiju i zenica, dužina filtruma, visina brade i čela.*
Cilj: *Autori su ovim istraživanjem želeli utvrditi da li su navedeni parametri dovoljni za determinaciju lepote i atraktivnosti lica ako se koriste pojedinačno.*
Zaključak: *Fotogrametrija lica, zahvaljujući korišćenju angularnih i linearnih parametara, ima široku primenu u poljima medicine, naročito u dermatologiji, u ortopediji vilica, u maksilofacijalnoj i plastičnoj hirurgiji, kao i u mnogim drugim poljima. Zbog brojnih prilagođavanja i napredaka, postala je veoma precizna i pristupačna, a dala je i značajan doprinos dijagnostici, negovanju pacijenata, tretmanima i ishodima mnogih slučajeva u medicini i stomatologiji.*

Ključne reči: *lepota, estetika, fotogrametrija, angularni parametri, linearni parametri*

Abstract

Introduction: *Beauty and attractiveness of a person's facial features are very subjective and also influenced by many factors, such as cultural, social, and personal. It is due to many complex neural mechanisms, that we are able to perceive everything, and also decide if something is attractive or not. The most common and the most significant factors associated with good facial aesthetics are symmetry and proportions of the face. It is important to note that they can be thoroughly analysed using photogrammetry, which represents a non-invasive technique that involves using photographs or 3D imaging methods to capture and analyze the craniofacial structures and features for diagnostic, treatment planning, monitoring and research purposes. When it comes to photogrammetry, angular parameters such as nasofrontal, nasolabial, mentolabial and facial profile angle and linear parameters such as facial width to height ratio, nasal width, interocular and interpupillary distance, philtrum length, chin and forehead height of the face are of great importance.*
Aim: *In this literature survey authors wanted to highlight if these measurements and parameters were enough for determining the beauty and attractiveness of a face if used on their own.*
Conclusion: *Facial photogrammetry has several applications in the field of medicine, particularly in areas such as dermatology, orthodontics, maxillofacial and plastic surgery, due to the usage of angular and linear parameters, as well as other purposes. With many advancements and adjustments, it has become accurate and accessible and has also significantly improved diagnostics, patient care, treatments and outcomes in various cases in medicine and dentistry.*

Key words: *beauty, aesthetics, photogrammetry, angular parameters, linear measurements*

Corresponding author:
Professor Gordana Filipović DMD, PhD
Faculty of Medicine, University of Niš
52 Dr. Zorana Djindjića Blvd., 18000 Niš Serbia
E-mail: filipovic.dr.gordana@gmail.com

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Šta je lepota?

Estetika ljudskog lica odnosi se na subjektivno opažanje lepote i atraktivnosti određenih karakteristika lica. Naučnici su došli do napretka u razumevanju neuronskih mehanizama koji se nalaze u osnovi opažanja lepote. Može se reći da fuziformna regija lica u temporalnom režnju i primarna vidna kora u okcipitalnom režnju imaju bitnu ulogu u opažanju kako lepote, tako i boja, oblika, karakteristika, ekspresija i atraktivnosti ljudskog lica[1]. Važnu ulogu, osim gorenavedenih struktura, ima i limbički sistem, koji je uključen u emocionalni aspekt doživljavanja estetike[2]. Mnogi standardi lepote, kao i načini opažanja estetike lica, mogu u velikoj meri varirati, u zavisnosti od kulture ili pojedinca. Ono što jedna osoba smatra atraktivnim na licu može biti suprotno iz perspektive druge osobe. Važno je istaći da su lepota i atraktivnost ljudskih karakteristika lica veoma subjektivne i da na njih mogu uticati mnogi faktori, kakvi su npr. kulturološki, društveni i lični faktori. Percepcija lepote takođe se može promeniti u različitim starosnim dobima. Ono što osoba smatra lepim i atraktivnim u mladosti može se razlikovati od onoga što osoba smatra atraktivnim i lepim u starosti. Na ova opažanja takođe mogu uticati emotivna povezanost, lična iskustva i, uopšte, prisustvo i osobine ličnosti pojedinca. Česti faktori i karakteristike koji su usko povezani sa dobrom estetikom lica i generalno dobrim zdravljem jesu simetrija, proporcije lica, čista koža, crte lica, oblik i boja očiju, oblik i punoća usana, facijalne ekspresije, kosa itd[3].

Fotogrametrija može, kada je reč o simetriji i proporcijama, poslužiti kao vrlo koristan alat pri merenju i analizi karakteristika lica. Fotogrametrija lica ima široku primenu u poljima medicine, naročito u dermatologiji, u ortopediji vilica, u maksilofacijalnoj i plastičnoj hirurgiji i u medicinskom imidžingu. Predstavlja neinvazivnu tehniku koja podrazumeva korišćenje fotografija ili 3D metode snimanja za beleženje i analiziranje kraniofacijalnih struktura i karakteristika, i to u svrhe dijagnostike, planiranja tretmana, monitoringa, ali i u svrhe istraživanja[4]. Zahvaljujući prilagođavanjima i napredovanju digitalnih imidžing tehnologija i softvera, fotogrametrija je postala preciznija i pristupačnija; takođe, značajno je doprinela negovanju pacijenata i ishodima lečenja u brojnim medicinskim poljima. Neki od ključnih faktora u fotogrametriji jesu estetski uglovi i linearni parametri lica[5].

What is beauty?

The aesthetic of the human face refers to the subjective perception of beauty and attractiveness in a person's facial features. Researchers have made progress in understanding the neural mechanisms underlying the perception of beauty. It is safe to say that the fusiform face area in the temporal lobe, and the primary visual cortex in the occipital lobe play a key role when perceiving beauty in human faces, as well as colours, shapes, facial features, expressions and attractiveness (Kanwisher, Yovel 2006). Besides these structures, the limbic system also has a significant role, as it is involved in the emotional aspect of aesthetic experiences (Kirsch, Urgesi, Cross 2016). Many beauty standards and perceptions of facial aesthetics can vary significantly between cultures and individuals. What one person finds attractive in a face may be different from someone else's preferences and perspectives. It is important to mention that perceptions of facial aesthetics are highly subjective and influenced by many factors, such as cultural, social, and personal. The perception of beauty can be changed with age. What is considered attractive in youth may differ from what is considered attractive or beautiful when it comes to an older age. That perception can also be influenced by the emotional connections, personal experiences and the overall presence and personality of the individual. Common factors and features that are often associated with good facial aesthetics and good overall health are symmetry, proportions, clear skin, facial features, eye shape and colour, lip shape and fullness, facial expressions, hair etc[3].

When it comes to symmetry and proportions, facial photogrammetry can be a very useful tool in measuring facial features. Facial photogrammetry has several applications in the field of medicine, particularly in areas such as dermatology, orthodontics, maxillofacial surgery, plastic surgery and medical imaging. It represents a non-invasive technique that involves using photographs or 3D imaging methods to capture and analyse the craniofacial structures and features for diagnostic, treatment planning, monitoring and research purposes[4]. It has become increasingly accessible and accurate with adjustments and advancements in digital imaging technology and software and has also significantly improved patient care and outcomes in various medical fields. Some of the key factors in photogrammetry are aesthetic angles and linear parameters of the face[5].

Angularni parametri

Estetski uglovi ukazuju na specifične parametre i proporcije koje se često smatraju atraktivnim ili lepim kada je u pitanju estetika lica. Ovi uglovi mogu pomoći ne samo plastičnim hirurzima i profesionalcima u kozmetologiji nego i pojedincima da procene balans i harmoniju ljudskog lica. Važno je pomenuti da ovi estetski uglovi nisu čvrsti standardi lepote; pre su smernice koje mogu varirati usled kulturoloških preferenci i individualnih karakteristika. Standardi lepote mogu se znatno razlikovati u različitim kulturama i vremenskim periodima, a ono što se smatra atraktivnim može biti i veoma subjektivno. Među najvažnijim uglovima lica izdvajaju se nazofrontalni, nazolabijalni, mentolabijalni ugao, kao i ugao profila lica[6].

Nazofrontalni ugao (Slika 1A) jeste ugao koji se formira na preseku između dveju linija: linije koja ide duž dorzuma nosa i linije koja ide duž čela. Dobro izbalansirani nazofrontalni ugao obično iznosi između 115 stepeni i 135 stepeni, a njegov značaj je višestruk. U poljima plastične hirurgije i estetike lica, nazofrontalni ugao koristi se za procenu harmonije i balansa lica. Hirurzi i kozmetički praktičari mogu uzeti ovaj ugao u obzir prilikom planiranja procedura poput rinoplastike i operacije podizanja obrva kako bi postigli jači estetski efekat i izbalansiran izgled lica[7]. Abnormalne vrednosti ovog ugla mogu poslužiti i kao pokazatelj određenih kraniofacijalnih ili genetskih poremećaja i sindroma koji za posledicu imaju kraniosinostoze. Ovi poremećaji i sindromi, kao što su Crouzonov, Pfeifferov i Apertov sindrom, karakterišu se prevremenim spajanjem jednog kranijalnog šava ili više kranijalnih šavova, što može rezultirati brojnim abnormalnostima. Mogu se javiti zaravnjen profil lica, zaravnjen koren nosa, ispupčeno čelo i plitke očne duplje[8]. U medicinskoj dijagnostici, merenja ovog ugla mogu biti deo šire evaluacije prilikom otkrivanja navedenih stanja.

Specijalisti ortopedije vilica takođe mogu koristiti nazofrontalni ugao kao deo procene facijalnih i zubnih struktura prilikom planiranja ortodontske terapije. Razumevanje i poznavanje veze između čela i nosa važno je za postizanje optimalnih rezultata u slučajevima loših pozicija zuba, odnosno malokluzija. Antropolozi uglavnom koriste nazofrontalni ugao za poređenje i proučavanje karakteristika lica u različitim populacijama, ali i za razumevanje evolucije čoveka i moguće varijacije. Ovaj ugao može pružiti uvid u morfološke različitosti etničkih grupa.

Angular measurements

The aesthetic angles of the face refer to specific measurements and proportions that are often considered attractive or beautiful in facial aesthetics. These angles can help plastic surgeons, cosmetic professionals, and individuals to assess facial harmony and balance. It is important to highlight that these aesthetic angles are not rigid standards for beauty but rather guidelines that can vary based on cultural preferences and individual features. Beauty standards can differ greatly across different cultures and time periods, and what is considered attractive can be highly subjective. Some of the most important aesthetic angles of the face include nasofrontal, nasolabial, and mentolabial angle, as well as facial profile angle[6].

The nasofrontal angle (Figure 1A) is an angle formed by the intersection of two lines: the line along the nasal dorsum and the line along the forehead. A well-balanced nasofrontal angle is typically between 115 and 135 degrees. It has great significance for several reasons. In the field of plastic surgery and facial aesthetics, the nasofrontal angle is used to assess facial harmony and balance. Surgeons and cosmetic practitioners may consider this angle when planning procedures like rhinoplasty or brow lift surgery to achieve a more aesthetically pleasing and balanced facial appearance[7]. Abnormal or deviated nasofrontal angle could also be an indicator of certain craniofacial abnormalities or genetic disorders and syndromes that result in craniosynostoses. These disorders and syndromes, such as Crouzon, Pfeiffer and Apert syndrome, are characterized by the premature fusion of one or more cranial sutures that can result in many abnormalities. These might include a flattened facial profile, flat nasal bridge, prominent forehead and shallow eye sockets[8]. In medical diagnostics, the measurements of this angle can be a part of a broader evaluation to identify such conditions.

Orthodontists may also use the nasofrontal angle as a part of their assessment of facial and dental structures when planning orthodontic treatment. Understanding and knowing the relationship between the forehead and the nose is important in achieving optimal results in cases of teeth misalignment i.e. malocclusions. Anthropologists usually use the nasofrontal angle to compare and study facial features across different populations, and to understand human evolution and variations.

Naučnici koji proučavaju morfologiju i razvoj lica često koriste nazofrontalni ugao kao jedan od parametara kada procenjuju kakav efekat određeni faktori, poput uticaja sredine i genetike, imaju na strukture lica. U forenzičkoj antropologiji, mera poput nazofrontalnog ugla može biti upotrebljena za procenu porekla neidentifikovanih ljudskih ostataka, čime se doprinosi samom procesu identifikacije. Stomatolozi, oralni i maksilofacijalni hirurzi mogu koristiti nazofrontalni ugao pri planiranju ortognatskih operacija kako bi ispravili teže slučajeve neslaganja gornjih i donjih vilica, budući da pruža informacije o vezi između nosa i čela[7].

Nazolabijalni ugao (Slika 1B) formira se na preseku između dveju linija: linije koja ide duž gornje usne i linije koja ide duž kolumele nosa; često se smatra atraktivnim kada se njegove vrednosti nađu u rangu između 90 stepeni i 110 stepeni[9].

Profesionalci i plastični hirurzi mogu koristiti ovaj ugao kao jedan od mnogih faktora prilikom planiranja i izvođenja procedura za korekciju stečenih ili urođenih deformiteta nosa i usana i u cilju poboljšanja estetike lica. Ako je ovaj ugao oštar, tj. ima manje od 90 stepeni, može dati izgled kratkog nosa, što se može videti kod određenih naslednih poremećaja ili nakon rinoplastike. Ako je ovaj ugao tup, odnosno veći od 120 stepeni, može rezultirati izduženim izgledom nosa, a to može biti povezano sa ubrzanim starenjem ili sa ostalim medicinskim stanjima[9].

Ugao profila lica (Slika 1C), koji procenjuje vezu između čela, nosa i brade, opisuje se crtanjem jedne linije, koja polazi od čela i ide do vrha nosa, i crtanjem druge linije, koja ide od vrha nosa do brade. Balansirani ugao profila lica karakteriše se blagim koveksitetom. Neophodan je za procenu estetike lica, dijagnostiku i planiranje tretmana kod različitih medicinskih i stomatoloških stanja, sprovođenje antropoloških istraživanja, a pomaže i u forenzičkoj identifikaciji. Služi kao korisno sredstvo za razumevanje i unapređivanje funkcije i forme lica[10].

Mentolabijalni ugao (Slika 1D) nastaje na preseku između dveju linija: linije koja ide duž donje usne i linije koja ide duž brade. Dobro definisani i najatraktivniji mentolabijalni ugao jeste onaj koji ima između 107 stepeni i 120 stepeni. Oštar mentolabijalni ugao rezultuje retrudovanim izgledom brade, dok tupi mentolabijalni ugao rezultuje protrudovanim izgledom brade.

This angle can provide insights into the morphological diversity among different ethnic groups. Researchers who are studying facial morphology and development often use the nasofrontal angle as one of the parameters to assess how certain factors, such as environmental influences or genetics can impact facial structure. In forensic anthropology, measurements like the nasofrontal angle can be used to estimate the ancestry of unidentified human remains, contributing to the identification process. Dentists, oral and maxillofacial surgeons may use the nasofrontal angle when planning orthognathic surgery to correct severe cases of jaw discrepancies, as it provides information about the relationship between the nose and the forehead[7].

The nasolabial angle (Figure 1B) is formed by the intersection of two lines: the line along the upper lip and the line along the columella of the nose and is often considered attractive when it falls within the range of 90 to 110 degrees[9].

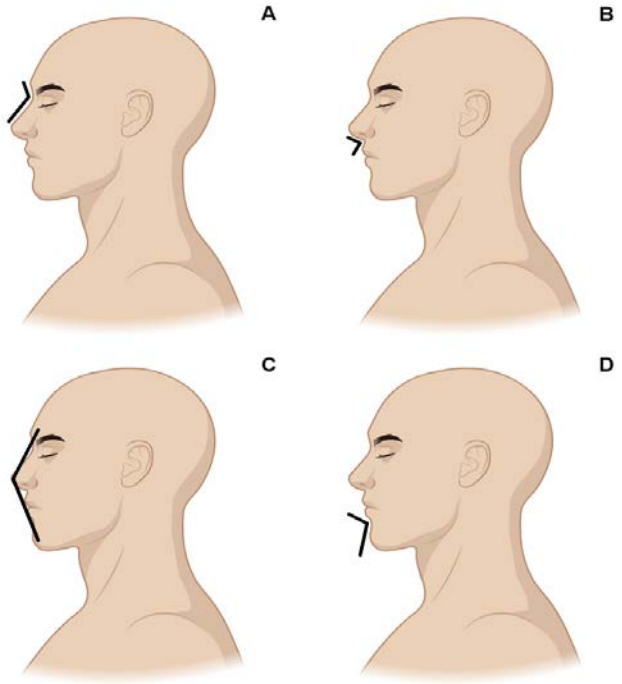
Professionals and plastic surgeons may use this angle as one of many factors when planning and performing procedures to correct acquired or congenital lip and nasal deformities and enhance facial aesthetics. If the angle is acute, which means less than 90 degrees, it can give the appearance of a short nose, which can be seen in certain congenital disorders or after rhinoplasty. If it is an obtuse angle or greater than 120 degrees, it can result in an elongated appearance of the nose, and that can be associated with faster ageing or other medical conditions[9].

The facial profile angle (Figure 1C), which assesses the relationship between the forehead, nose, and chin, is evaluated by drawing a line from the forehead to the tip of the nose and another line from the tip of the nose to the chin. A balanced profile angle is often characterized by a slight convexity. It is important for assessing facial aesthetics, diagnosing and planning treatment for various medical and dental conditions, conducting anthropological research, and aiding in forensic identification. It serves as a valuable tool for understanding and improving facial function and form[10].

The mentolabial angle is formed by the intersection of two lines: the line along the lower lip and the line along the chin. A well-defined and the most attractive mentolabial angle falls between 107 and 120 degrees.

Mentolabijalni ugao takođe se koristi kao referentna tačka prilikom planiranja različitih procedura, uključujući operacije augmentacije i redukcije veličine brade, ortognatske operacije i mnoge procedure na usnama[11].

An acute mentolabial angle results in a retruded chin appearance, and an obtuse mentolabial angle results in a protruded chin appearance. The mentolabial angle is also used as a reference point when planning various procedures, including augmentation or reduction surgery of the chin, orthognathic surgery and many lip procedures[11].



Slika 1. Važni angularni parametri estetike lica

Figure 1. Significant angular aesthetic parameters of the face

Linearni parametri

Linearni parametri estetike lica predstavljaju specifične mere i rastojanja koja se često upotrebljavaju za procenu estetike i proporcija lica. Ovi parametri mogu biti od pomoći i u evaluaciji balansa i harmonije karakteristika lica. Treba imati na umu da estetika lica može varirati u zavisnosti od kulturoloških i individualnih preferenci; stoga, ni ove mere nisu čvrsti standardi lepote, već mogu poslužiti samo kao smernice. U najčešće korišćene linearne parametre estetike lica spadaju: odnos širine i visine lica, širina nosa, rastojanje između očiju, rastojanje između zenica, dužina filtruma, visina brade i visina čela[12].

Odnos širine i visine lica (FWHR) (Slika 2A) predstavlja širinu lica (merenu između jagodica) podeljenu sa visinom lica (merenom od gornje usne do vrha čela).

Linear measurements

Linear aesthetic parameters of the face refer to specific measurements or distances that are often used to assess facial aesthetics and proportions. These parameters help evaluate the balance and harmony of facial features. We need to keep in mind that facial aesthetics can vary based on cultural and individual preferences, so these measurements are not rigid standards for beauty. They can only serve as guidelines. Most common linear aesthetic parameters of the face include facial width-to-height ratio, nasal width, interocular distance, interpupillary distance, philtrum length, chin height and forehead height[12].

Facial width-to-height ratio (FWHR), which measures the width of the face (measured across the cheekbones) divided by the height of the face (measured from the upper lip to the top of the forehead).

Studija je pokazala da se pojedinci sa određenim vrednostima ovog odnosa posmatraju kao dominantniji i atraktivniji ukoliko vrednost tog odnosa iznosi oko 1,7, što znači da je širina lica 1,7 puta veća od njegove visine[13].

Veće vrednosti ovog odnosa povezuju se sa većom dominantnosti, agresivnosti, muževnosti i fizičkom snagom, dok su niže vrednosti ovog odnosa odlika osoba veće pouzdanosti i ženstvenosti[14]. Studija je pokazala da među osobama muškog i ženskog pola ima razlika u ovim odnosima – više vrednosti ovog odnosa zastupljenije su kod muškaraca nego kod žena. Ova se razlika pripisuje polnom dimorfizmu, s obzirom na to da muškarci uglavnom imaju šira lica od žena. Iako odnos širine i visine lica može pružiti uvid u određena društvena i psihološka razmatranja, treba naglasiti da on predstavlja samo jedan od mnogobrojnih faktora koji doprinose proceni atraktivnosti lica[15].

Širina nosa (Slika 2B) jeste linearni parametar koji se meri između spoljašnjih ivica nozdrva. Ima važnu ulogu u formiranju balansa i harmonije lica. Pri estetskim evaluacijama, nos koji je proporcionalan ostalim crtama lica često se smatra atraktivnijim. Prekomerna širina nosa ili nos koji nije proporcionalan može narušiti harmoniju lica i biti uzrok brige za pojedince. U idealnim situacijama, atraktivna širina nosa bila bi slična ili jednaka srednjoj petini lica[16].

Rastojanje između očiju (Slika 2C), koje pokazuje distancu između centara obaju oka, takođe se može koristiti u proceni proporcija lica[17]. Rastojanje između zenica, odnosno distanca između obeju zenica igra važnu ulogu u stomatološkoj protetici i oftalmologiji; smatraju se estetski zadovoljavajućim ukoliko su jednake ili makar slične širini jednog oka. Isto se može reći i za interkantalno rastojanje (distanca između unutrašnjih uglova obaju oka)[18].

Dužina filtruma (Slika 2D), koji predstavlja žleb između gornje usne i baze nosa, može se uzeti u obzir kada je posredi estetika lica, ali nije od tolikog značaja kao prethodno opisani parametri. Prema istraživanju, idealna dužina filtruma iznosi oko 12 milimetara kod osoba ženskog pola, a nekoliko milimetara više kod osoba muškog pola[19].

Visina brade (Slika 2E) predstavlja rastojanje između donje usne i brade i važan je parametar u evaluaciji proporcija lica. Dobro definisana brada može doprineti simetriji lica, što se često smatra znakom lepote. Pol i godine života takođe mogu imati uticaj na izgled brade.

Research has suggested that individuals with certain FWHRs may be perceived as more dominant or attractive if their facial width-to-height ratio is around 1.7, meaning that the face is 1.7 times wider than it is tall[13]. However, higher FWHR values have been associated with perceptions of greater dominance, aggression, masculinity, and physical strength. On the contrary, lower FWHR values have been associated with perceptions of greater trustworthiness and femininity[14]. Research has indicated that there can be sex-related differences in FWHR, with males tending to have higher values of FWHR when compared to females. This difference is attributed to sexual dimorphism, where males typically have broader faces than females. While FWHR can provide insights into certain social and psychological perceptions, it is very important to mention that it is just one of too many factors contributing to facial attractiveness and perception[15].

The width of the nose or nasal width (Figure 2B) is a linear parameter measured between the outer edges of the nostrils. It plays a significant role in the overall balance and harmony of the face. In aesthetic evaluations, a nose that is proportionate to the rest of the facial features is often considered more attractive. Excessive nasal width or a disproportionately wide nose can disrupt facial harmony and may be a concern for some individuals. Ideally, an attractive nose would be approximately or equal to the middle fifth of the face[16].

Interocular distance (Figure 2C), which measures the distance between the centres of the eyes, can also be used to assess facial proportions[17]. Interpupillary distance, the distance between the pupils of the eyes, plays an important role in prosthodontics and ophthalmology. It is considered as aesthetically pleasing if it is roughly equal or similar to the width of one eye. The same things can be said for the intercanthal distance (distance between the inner corners of the eyes)[18].

Philtrum length (Figure 2D), which is the groove between the upper lip and the base of the nose, can be considered in facial aesthetics, but it is not as significant as the parameters that have been previously mentioned. According to the research, the ideal length of the philtrum is roughly 12 millimetres for women, and a couple of millimetres longer for men[19].

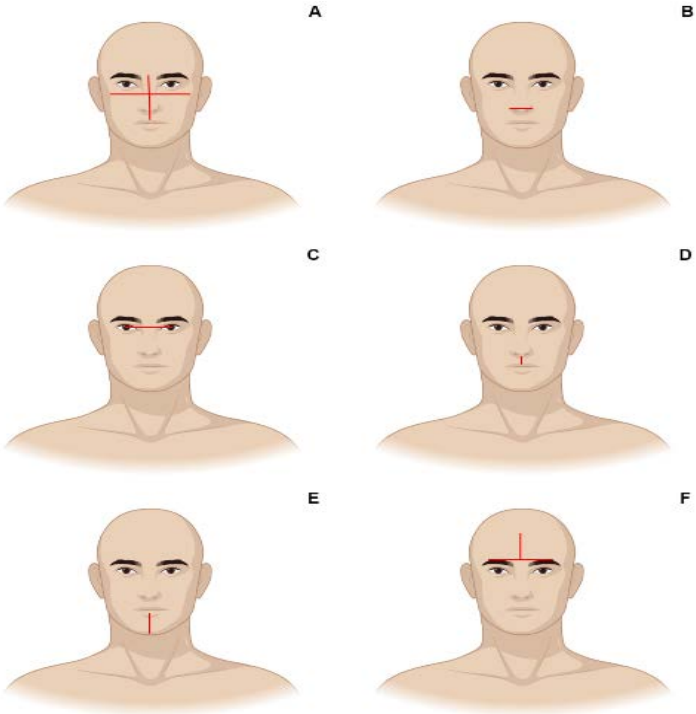
Chin height (Figure 2E), the distance between the lower lip and the chin, is an important parameter in evaluating facial proportions.

Kratka i zaobljena brada smatra se ženstvenom, a duža i više uglasta brada uglavnom se povezuje sa muževnijim izgledom[20]. Punija brada često se može zapaziti kod mlađih osoba. Sa starenjem može doći do postepenog gubitka mekih tkiva, što može dovesti i do gubitka visine brade.U određenim slučajevima, pojedinci sa gubitkom ili sa već slabom bradom mogu se osetiti nesigurno u vezi sa svojim izgledom, te posegnuti za kozmetičkim procedurama. Visina brade takođe može imati uticaj na funkcije žvakanja i govora. U slučajevima ekstremnih abnormalnosti brade, neslaganja između vilica i ostalih odstupanja mogu se javiti i smetnje u funkciji, pa zato korektivne operacije, poput preoblikovanja kosti i ortognatske operacije, mogu biti neophodne za poboljšanje ovih funkcija, kao i za povratak harmonije lica. Idealna visina brade iznosila bi između 13 milimetara i 23 milimetara kod muškaraca, odnosno između 10 milimetara i 20 milimetara kod žena[20].

Visina čela (Slika 2F), koja se meri od linije kose do najviše tačke obrva, može generalno doprineti proporcijama lica. Standardi lepote mogu u velikoj meri varirati; tako se kod pojedinih naroda određena visina čela može smatrati atraktivnijom ili poželjnijom, što dovodi do toga da ih pojedinci cene manje ili više. Visoko i više vertikalno orijentisano čelo mahom se smatra ženstvenim, dok se kraće i više horizontalno orijentisano čelo može smatrati muževnijim[21]. Varijacije kod linije kose takođe mogu imati uticaj na izgled čela, što može biti izvor brige za određene pojedince. Prema istraživanju, idealna visina čela nalazi se u rasponu između pet centimetara i osam centimetara[21].

A well-defined chin can contribute to facial symmetry, which is often considered a sign of beauty. Gender and age can also have an impact on the chin. A shorter and rounded chin is considered feminine, while a taller and more angular chin is usually associated with a more masculine look[20]. Plump chin is often found in young people. However, as people age, they might experience a gradual loss of soft tissue, and that can lead to a decrease in its height. In some cases, individuals with a receding or weak chin may feel insecure about their profile and may consider cosmetic procedures. Chin height can also affect bite function and speech. In cases of extreme chin abnormalities, jaw misalignments, and other discrepancies, functional issues may arise, and corrective surgeries, such as bone reshaping and orthognatic surgery, may be necessary to improve these functions, and also to restore overall facial harmony. The ideal chin length would be between 13 and 23 millimetres for men, and between 10 and 20 millimetres for women[20].

Forehead height (Figure 2F), which is measured from the hairline to the highest point of the eyebrows, can contribute to overall facial proportions. Standards of beauty can vary significantly. In some cultures, a certain forehead height may be considered more attractive or desirable, leading individuals to value it more or less. A taller and more vertically oriented forehead is usually considered feminine, while a shorter and more horizontally oriented forehead may be considered more masculine (Salinas, Liu, Sharaf 2023). Hairline variations can also have an impact on the forehead, and they may be a source of concern for some individuals. According to the research, the ideal height is within the range between 5 and 8 centimetres[21].



Slika 2. Značajni linearni parametri lica
Figure 2. Significant linear parameters of the face

Zaključak

Fotogrametrija lica, zahvaljujući korišćenju angularnih i linearnih parametara, ima široku primenu u poljima medicine, naročito u dermatologiji, u ortopediji vilica, u maksilofacijalnoj i plastičnoj hirurgiji, kao i u mnogim drugim poljima. Zbog brojnih prilagođavanja i napredaka, postala je veoma precizna i pristupačna, a dala je i značajan doprinos dijagnostici, negovanju pacijenata, tretmanima i ishodima mnogih slučajeva u medicini i stomatologiji. Uprkos činjenici da je fotogrametrija veoma korisna u brojnim medicinskim granama i specijalnostima, linearni ili angularni parametri, nažalost, ne mogu definitivno determinisati lepotu i atraktivnost lica ukoliko se koriste zasebno, s obzirom na to da na njih utiče složeni splet faktora, vezan isključivo za pojedinca.

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Conclusion

Facial photogrammetry has several applications in the field of medicine, particularly in areas such as dermatology, orthodontics, maxillofacial and plastic surgery, due to the usage of angular and linear parameters, as well as other purposes. With many advancements and adjustments, it has become accurate and accessible and has also significantly improved diagnostics, patient care, treatments and outcomes in various cases in medicine and dentistry. Despite being useful in numerous medical specialties and branches, unfortunately, linear or angular parameters cannot definitively determine the beauty or attractiveness of a face on their own, because they are influenced by a complex interplay of factors which almost solely lie in the individual.

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PREGLED NEDAVNIH DOSTIGNUĆA U DEČJOJ STOMATOLOGIJI

A REVIEW OF RECENT ADVANCES IN PAEDIATRIC DENTISTRY

***Aleksandar Dimkov*[1]**

[1]UNIVERZITET „SV. ĆIRILO I METODIJE", STOMATOLOŠKI FAKULTET, DEPARTMAN ZA DEČJU I PREVENTIVNU STOMATOLOGIJU, SKOPLJE, SEVERNA MAKEDONIJA

[1] UNIVERSITY "SS. CYRIL AND METHODIUS", FACULTY OF DENTAL MEDICINE, DEPARTMENT OF PAEDIATRIC AND PREVENTIVE DENTISTRY, SKOPJE, NORTH MACEDONIA

Sažetak

Uvod: *Do značajnih izmena u dečjoj stomatologiji došlo je usled razvoja tehnologije, materijala i znanja o bolestima. Kada se radi sa decom, najvažnijniji su prijatnost, brzina, bezbednost i primena konzervativne terapije. Iako se sve navedeno odnosi i na odrasle pacijente, od posebnog je značaja da se sa stomatološkim pregledima započne u detinjstvu, ali i da ovo iskustvo ne bude stresno ni za pacijente ni za roditelje. Uvođenje i korišćenje nove tehnologije izazvalo je promenu paradigme u stomatološkoj praksi, obeleženu razvojem novih i superiornih restaurativnih materijala koji omogućavaju da se ukloni manje zubnog tkiva. Sada smo postigli terapijske ciljeve otkrivene u pružanju minimalno invazivne stomatologije. Rana stomatološka dijagnoza postala je u poslednje vreme sve važnija. Poslednjih nekoliko godina, rano detektovanje karijesa dobilo je na značaju, budući da je konzervativna stomatologija i dalje u prvom planu. Stomatolog treba da naglasi važnost rane identifikacije karijesa i da ukaže na najmanje invazivne alternative lečenja, posebno u dečjem uzrastu. Tradicionalne metode otkrivanja karijesa često ne uočavaju rane lezije gleđi koje se nisu razvile u kavitaciju. Upravo zbog toga, razvijeno je nekoliko inovativnih strategija za rano otkrivanje karijesa.*
Cilj: *Cilj ovog rada bio je da pruži opširne informacije o novim restaurativnim materijalima i tehnologijama za otkrivanje karijesa i da sumira nedavna dostignuća u dečjoj stomatologiji.*
Zaključak: *U ovom preglednom radu predstavljena je oprema koja se trenutno koristi u stomatološkoj dijagnostici, kao i ona koja u te svrhe može biti korišćena u budućnosti. Razvoj tehnologije je toliko brz da je skoro nemoguće ostati u toku. Shodno tome, možda je za svakog pedodonta ili pedodontsku kliniku najbolje rešenje da odabere opremu koja se najviše isplati.*

Ključne reči: *materijali za restauraciju zuba, tehnologija snimanja, laser, fluorescencija, spektroskopija, zvučni talasi, Cone Beam kompjuterizovana tomografija*

Abstract

Introduction: *As a result of developments in technology, materials, and illness knowledge, paediatric dentistry has experienced major changes. When dealing with children, comfort, speed, safety, and conservative therapies are paramount. Of course, this also applies to adults, but getting youngsters started with dental appointments and making the experience stress-free for both patients and parents is extremely vital. The introduction and use of new technology caused a paradigm change in the practice of dentistry. This has been marked by the development of new and superior restorative materials that allow us to remove less tooth structure. We have now achieved the therapeutic goals discovered in giving more minimally invasive dentistry. Early dental diagnosis has become increasingly important in recent years. Early detection of dental caries has grown in relevance in recent years as conservative dentistry has remained at the forefront. The dentist should emphasize early identification of dental caries and the least invasive treatment alternatives, especially in paediatric patients. Traditional caries detection methods frequently miss early enamel lesions that have not developed into cavitation. As a result, several innovative strategies for detecting cavities early have been developed.*
Aim: *The purpose of the current literature is to provide broad information regarding new restorative materials and caries detection technologies and summarize recent advances in paediatric dentistry.*
Conclusion: *This overview highlighted a huge variety of current equipment that is either now used or can be utilized in dental diagnostics. Some of these devices are rather pricey and take up a lot of room. Technology evolves so quickly that it is impossible to stay up. As a result, possibly the best answer for each pedodontist or pedodontics clinic is to select the equipment with the greatest cost benefit.*

Key words: *tooth restorative materials, imaging technology, laser, fluorescence, spectroscopy, sound waves, Cone Beam Computed Tomography*

Corresponding author:
Professor Aleksandar Dimkov DMD, PhD
"Ss. Cyril And Methodius", Faculty Of Dental Medicine Skopje,
Goce Delčeva 9, Blvd North Macedonia
adimkov@stomfak.ukim.edu.mk

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Terapija karijesa od Black-a do danas

Prema rezultatima Nacionalne agencije o zdravlju i ishrani, karijes je najčešće hronično stanje kod dece. Pet puta je češći od astme i sedam puta češći od polenske groznice[1].

Prednosti restaurativne terapije čine: uklanjanje kavitacija ili defekata kako bi se eliminisala područja sklona karijesu, omogućilo zaustavljanje progresije demineralizacije zuba; obnavljanje strukture i funkcije zuba; sprečavanje širenja infekcije u zubnu pulpu i sprečavanje migracije zuba usled gubitka zubnih struktura. Restaurativna terapija može smanjiti životni vek zuba budući da ih čini sklonijim frakturama, ponavljajućim lezijama, neuspehu restauracije, izlaganju pulpe tokom ekskavacije karijesa i mogućim oboljenjima pulpe. Osim toga, postoji opasnost od jatrogenih povreda susednih zuba.

Konvencionalna metoda lečenja karijesa podrazumeva postavljanje materijala za restauraciju zuba. Koncept G. V. Blacka „ekstenzija u cilju prevencije", koji je bio standard duže od jednog veka, sada se može smatrati arhaičnim[2]. Ovaj pristup je podrazumevao uklanjanje zubnog tkiva proširenjem preparacije kaviteta u nekariozne žlebove. U Blackovo vreme nije bilo strategija, metoda i materijala za prevenciju karijesa, a ni validiranih alternativnih lekova. Karijes se obično lečio u kasnijoj fazi. Karijesni proces, uključujući cikluse demineralizacije i remineralizacije, pogrešno se tumačio. Tada je materijal najčešće korišćen za restauraciju zuba bio amalgam, a preparacija kaviteta uslovljavala je potrebu za retencijom. Prednosti amalgama ogledaju se u jednostavnosti primene i jakoj čvrstoći na pritisak. Amalgamske plombe imaju razne nedostatke, među kojima su slabljenje zuba, nemogućnost formiranja hemijske veze sa zubima i perkolacija, koja izaziva sekundarni karijes i promenu boje zuba.

Zahvaljujući Dawsonu i Makinsonu, koji su devedesetih godina prošlog veka prvi upotrebili izraz „minimalna interventna stomatologija" (sada se umesto toga koristi „minimalno invazivna stomatologija" ili MID), došlo je do pomaka u načinu preparacije kaviteta za primenu restaurativnih materijala[3]. Ovim konceptom naglašavaju se rana identifikacija i procena rizika od pojave karijesa, remineralizacija demineralizovane gleđi i dentina, prevencija karijesa, manje invazivne operativne procedure i mogućnost popravke umesto zamene restauracija. Sveobuhvatni cilj je da se omogući da zubi očuvaju svoju funkciju do kraja života.

Caries treatment from Black today

According to the National Health and Nutrition Examination Survey findings, caries is the most frequent chronic condition among children. It is five times as frequent as asthma and seven times as common as hay fever[1].

Restorative therapy benefits include removing cavitations or defects to eliminate caries-prone areas, halting the progression of tooth demineralization, restoring tooth structure and function, preventing the spread of infection into the dental pulp, and preventing tooth shifting due to tooth structure loss. Restorative therapy has the potential to shorten the lifespan of teeth by rendering them more prone to fracture, recurring lesions, restoration failure, pulp exposure during caries excavation, and future pulpal problems, in addition to the danger of iatrogenic injury to neighboring teeth.

The conventional method of treating caries is to put a dental restorative. G. V. Black's "extension for prevention" concept was the standard for more than a century and might be regarded archaic now[2]. This approach eliminated extra tooth structure by extending the cavity preparation into noncarious grooves. There was a paucity of strategies, methods, and materials for caries prevention at the time of Black, as well as a lack of validated alternative remedies. Caries was commonly treated at a later stage. There was a misunderstanding of the caries process, including the demineralization and remineralization cycles. At the time, the predominant dental restorative material was amalgam, and the preparation design mirrored the necessity to induce retention. Amalgam has advantages such as simplicity of application and strong compressive strength. Amalgam fillings have various disadvantages, including weakening the teeth, the inability to form a chemical bond with the teeth, filling leakage causing secondary caries, and tooth discoloration.

Thanks to Dawson and Makinson, who were the first to coin the phrase "minimal interventional dentistry" (now known as "minimally invasive dentistry" or MID) in the 1990s, there was a shift in the way cavities were prepared for the application of restorative materials[3]. Early caries identification and risk assessment, remineralization of demineralized enamel and dentin, caries prevention, less invasive operational procedures, and the ability to repair rather than replace restorations are all emphasized in this concept. The overarching objective is to keep the teeth functioning for the rest of one's life. This conservative approach decreases restorative time, pain, tension, and anxiety, all of which are critical factors for paediatric dentistry patients.

Ovaj konzervativni pristup smanjuje vreme restauracije, bol, napetost i anksioznost – kritične faktore za pacijente dečjih stomatologa. U MID-u se akcenat stavlja na upotrebu adhezivnih stomatoloških materijala i metoda. Ovi materijali omogućavaju uklanjanje karijesa sa minimalnom preparacijom kaviteta, što rezultira smanjenim gubitkom strukture zuba. Tako je zahvaljujući činjenici da nema potrebe za uključivanjem retencije u preparaciju[4].

Uzrok sve učestalije upotrebe kompozita leži u napretku tehnologije punila i potrebi javnosti da restauracije budu zadovoljavajuće u estetskom smislu[5]. Za razliku od amalgama, kompoziti imaju nekoliko prednosti. Prvo, mogu se napraviti manje preparacije kaviteta, što rezultira boljim očuvanjem zubnih struktura. Drugo, mehanička retenciija više nije potrebna[6]. Međutim, nije sve tako jednostavno. Kompozitnim smolama i zamenama od akrilne smole davala se prednost 1978. godine pošto su imale stabilniju boju, duže su se lepile za zub i češće odgovarale boji zubnog tkiva. Ipak, vremenom bi ove smole počele da se razgrađuju. Na sreću, kreativnost je trijumfovala i otkriveno je da u restauraciju treba uključiti i proceduru nagrizanja kada se koristi vezujuća supstanca. Stoga se restauracija i adhezija započinju unutar zuba češće nego sa spoljašnje strane. Hibridni kompoziti poboljšali su se devedesetih i dvehiljaditih godina, a razlike su postale toliko velike da se ova tehnologija počela efikasno koristiti na bočnim (zadnjim) zubima. Današnje kompozite koristi najveći deo stomatologa. Kao njihove prednosti možemo izdvojiti sledeće: prilagođavaju se nepravilnosti zuba; mogu se postaviti u sloju koji odgovara strukturi zuba; dostupna je široka paleta boja koja odgovara postojećim zubima; veoma su fleksibilni.

Premda je šezdesetih godina prošlog veka bilo dostupno nekoliko restaurativnih materijala, uključujući amalgam, kompozit, livene legure i dr., nijedan od njih nije se mogao odrediti kao optimalni restaurativni materijal. Idealan materijal za restauraciju jeste onaj koji je estetski prijatan, biokompatibilan, adhezivan, antikancerogen i dostupan po razumnoj ceni. Istraživači su tada počeli da rade na razvoju supstance koja ne bi samo delovala kao restaurativno sredstvo već bi i zamenila gleđ i dentin. Kao što su Vilson i Kent istakli sedamdesetih godina, ovo je 1969. godine dovelo do uvođenja glas-jonomer cementa (GJC). Stakleni polialkenoati su materijali koji se sastoje od kalcijum-aluminofluorosilikatnog ili stroncijum-aluminofluorosilikatnog staklenog praha (baze) i polimera rastvorljivog u vodi (kiseline).

The use of adhesive dental products and methods is emphasized in MID. These materials enable caries removal with a minimum cavity preparation design, resulting in reduced tooth structural loss. This is due to the fact that there is no need to include retention in the preparation[4].

Composites are being used more often. The cause for this is advancements in filler technology and public demand for more aesthetically pleasing restorations[5]. As opposed to amalgam, composites have several advantages. First, smaller cavity preparations can be made, resulting in more residual tooth structure. Second, mechanical retention is no longer required[6]. But it wasn't quite that straightforward. Composite resins and acrylic resin replacements were widely favored in 1978 because they had higher color stability, clung to the tooth longer, and were more likely to match the color of the tooth tissue. However, as time passed, these resins began to degrade more regularly as well. Fortunately, creativity triumphed, and it was discovered that restorations should incorporate an etching procedure when the bonding substance was used. As a result, the restoration and adhesion began within the tooth rather than only on the exterior. Hybrid composites improved in the 1990s and 2000s, and the differences grew so large that this technology began to be utilized effectively on posterior (back) teeth. Today's composites are utilized by the vast majority of dentists. They have the benefit of adjusting to a tooth's irregularity; their thickness may be stacked to conform to the tooth's structure; a wide color range is available to match existing teeth; and it is very flexible.

Back in the 1960s, there were several restorative materials available, including amalgam, composite, cast alloys, and so on, but none of them could be classified as optimal restorative materials. An ideal restorative material is one that is aesthetically pleasing, biocompatible, adhesive, anticarcinogenic, and reasonably priced. The researchers then started working on developing a substance that would not only operate as a restorative but also replace enamel and dentin. As Wilson and Kent described in the 1970s, this resulted in the introduction of *Glass Ionomer Cement (GIC*) in 1969. Glass polyalkenoates are materials composed of calcium or strontium aluminofluorosilicate glass powder (base) and a water-soluble polymer (acid). Kent referred to such materials as "glass ionomer" cements, and the term has become part of dental parlance. The benefits of glass ionomer cement include adhesion, good marginal seal, fluoride release, and biocompatibility.

Kent je takve materijale nazvao „glas-jonomernim" cementima, a termin je postao deo stomatološkog rečnika. Prednosti glas-jonomer cemenata jesu adhezija, dobro rubno zaptivanje, oslobađanje fluorida i bio-kompatibilnost. Međutim, imali su razočaravajuće kliničke učnike kod mlečnih molara budući da su osetljivi na dehidraciju u ranoj fazi procesa vezivanja i krti, što ih čini nepodesnim za upotrebu u područjima izloženim pritisku[7-9]. Stoga, pokušalo se da se svojstva GJC-a poboljšaju modifikovanjem hemijskog sastava originalnog praha. U skladu sa tim, napravljen je veći broj modifikacija.

Smolom modifikovani glas-jonomeri: Da bi se promenile fizičke karakteristike i translucencija standardnog GJC-a, u kiselu tečnu komponentu dodate su male količine grupa smole koje se polimerizuju svetlošću (često 2-hidroksietil metakrilat ili HEMA).

Metalom ojačani glas-jonomeri: Formiranje „kermeta" (keramika–metal) postiže se kombinovanjem praha amalgamske legure i sinterovanih čestica srebra sa staklenom komponentom. Bilo je dokaza o značajnom poboljšanju fizičkih kvaliteta GJC-a. Naknadno istraživanje o ovom materijalu otkrilo je da ima manju otpornost na karijes od običnih glas-jonomera.

Visokoviskozni autocare glas-jonomeri: Ovi cementi su dizajnirani da obezbede robusnu adhezivnu restauraciju, sa sposobnošću oslobađanja fluora. Pogodni su za lečenje pacijenata u udaljenim, nerazvijenim oblastima u kojima stomatološka nega nije dostupna.

Polikselinski modifikovane kompozitne smole (kompomeri): Rečju „kompomer" implicira se želja da se integrišu komponente i prednosti GJC-a i kompozita. Imali su estetiku kompozita i svojstvo oslobađanja fluora, karakteristično za GJC. Međutim, oslobađanje fluora bilo je manje nego kod klasičnog GJC-a; zidovi kaviteta malo su apsorbovali fluor zbog toga što sredstvo za vezivanje smole funkcioniše kao barijera.

Cirkonijumom ojačan GJC: Cirkonijumom prožet glas-jonomer cement (ZIRCONOMER) nov je dodatak porodici GJC-a, razvijen radi prevazilaženja svih poteškoća koje su dosad postojale kod tradicionalnih jonomera. Mehaničke osobine GJC praha poboljšane su kombinovanjem hidroksiapatita i cirkonijuma (HAp/ZrO2) pri 4% zapreminskoj koncentraciji.

GJC ojačan vlaknima: Kada su se aluminijumska vlakna iskombinovala sa staklenim prahom, poboljšala su dubinu očvršćavanja, otpornost na habanje i čvrstoću na savijanje, a smanjila polimerizaciju.

However, it had a disappointing clinical performance in primary molars because they are sensitive to dehydration early in the setting process and are brittle materials, making them unsuitable for use in stress-bearing areas[7-9]. Therefore, attempts have been made to improve the properties of GICs by modifying the chemical composition of the original powder. For these reasons, a vast number of modifications have been made to GIC.

Resin Modified Glass Ionomer: To change the physical characteristics and translucency of standard GIC, small amounts of light-polymerizable resin groups (often 2-hydroxyethyl methacrylate or HEMA) were added to the acidic liquid component.

Metal Reinforced Glass Ionomers: Forming a "Cermet" (ceramic-metal) by combining amalgam alloy powder and sintered silver particles with a glass component. There was evidence of a considerable improvement in the physical qualities of GICement. Further study on this material revealed that it had lower caries resistance than ordinary glass ionomers.

High-Viscosity Autocare Glass Ionomers: These cements were designed to provide a robust adhesive restoration with fluoride-releasing capabilities to treat patients in distant, underdeveloped areas where dental care is unavailable.

Polyacid Modified Composite Resins (Compomers): The word "Compomer" implies a desire to integrate the components and advantageous qualities of both GIC and composite. They had the aesthetics of composites as well as the fluoride-releasing attribute of GIC, albeit the fluoride release was minor when compared to normal GIC since there was little fluoride absorption by the cavity walls due to the resin bonding agent functioning as a barrier.

Zirconia Reinforced GIC: Zirconia-infused glass ionomer cement (ZIRCONOMER) is a new addition to the GIC family that has been developed to overcome all of the difficulties that have afflicted traditional ionomers up to this point. The mechanical properties of GIC powder were optimized by combining Hydroxyapatite and Zirconia (HAp/ZrO2) at 4% volume concentration.

GIC with Fibre Reinforcement: When alumina fibres were combined with glass powder, they improved curing depth, wear resistance, and flexural strength while decreasing polymerization. A continuous network/scaffold of alumina and silicon dioxide ceramic fibres is used in this polymeric stiff inorganic matrix technology.

Kontinuirana mreža/nosača od aluminijum-dioksid i silicijum-dioksid keramičkih vlakana koristi se u ovoj tehnologiji polimerne krute neorganske matrice.

GJC koji sadrži prolin: Posredi je GJC koji sadrži amino-kiseline, sa poboljšanom površinskom tvrdoćom, brzim vezivanjem i većom sposobnošću sorpcije vode bez uticaja na oslobađanje fluorida. Procenjena je i njegova upotreba u svojstvu koštanog cementa zbog niske citotoksičnosti i jake bio-kompatibilnosti.

Kalcijum-aluminat GJC: Ova svojstva GJC-a otkrivaju mešavinu kalcijum-aluminata i GJC-a za cementiranje. Prednosti su viši pH tokom očvršćavanja, manje marginalno curenje, poboljšana biokompatibilnost i povećana stabilnost i snaga.

Nanoglas-jonomeri sa modifikacijom praha: Kombinovanje standardnog glas-jonomera sa staklenim česticama nano veličine, kao što su nanoapatit i nanofluorapatit, smanjuje vreme vezivanja i povećava čvrstoću na pritisak i modul elastičnosti nakon sedam dana u destilovanoj vodi.

Smolom modifikovani GJC (SMGJC) sa nanopunjenjem: Da bi se unapredila mehanička svojstva, SMGJC-ima su dodati punioci nano veličine i biokeramičke čestice. Umesto mikromehaničke interakcije, otkrivena je povećana jonska veza sa zubom.

GJC impregnirani hlorheksidinom oslobodili su približno 10 ppm fluorida u toku prvih 48 sati nakon postavljanja u kavitet. Može im se dodati hlorheksidin-diglukonat kako bi se pojačala njihova antibakterijska svojstva[10-16].

Pored savremenih kompozitnih i glas-jonomer cemenata, postoji nekoliko materijala koje možemo prikazati kao stomatološke materijale koji se koriste odnosno kao materijale koji će se koristiti u dečjoj stomatologiji. U nastavku rada navode se neki od njih.

Srebro-diamin-fluorid (SDF) predstavlja fluoridnu tečnost na bazi srebra koja se koristi za sprečavanje širenja karijesa denaturacijom i razbijanjem mikroorganizama u zahvaćenom regionu. SDF se koristi kao dopuna restaurativnoj nezi zbog svoje sposobnosti da uđe u dentinske tubule i smanji bol u dubokim lezijama onda kada se primenjuje u indirektnom prekrivanju pulpe. Kada se uzima sam, SDF ima sposobnost da zaustavi početne lezije. Uklanjanje ovih lezija kod dece u ranom uzrastu, koja nisu u stanju da se pridržavaju pravila u konvencionalnom stomatološkom okruženju, može eliminisati potrebu za lečenjem pod opštom anestezijom ili za restaurativnim procedurama[17].

GIC-containing proline: An amino acid-containing GIC with improved surface hardness, rapid setting, and higher water sorption capabilities without impacting fluoride release. It was also evaluated for usage as a bone cement due to its low cytotoxicity and strong biocompatibility.

Calcium Aluminate GIC: This GIC's properties reveal a mixture of calcium aluminate and luting GIC. The benefits include a higher pH during curing, less marginal leakage, enhanced biocompatibility, and increased stability and strength.

Powder-Modified Nano Glass Ionomers: Combining standard glass ionomer with nano-sized glass particles such as nanoapatite and nano-fluorapatite reduced setting time and increased compressive strength and elastic modulus after 7 days in distilled water.

Nano-Filled Resin-Modified GIC: To increase mechanical qualities, nano-sized fillers, and bioceramic particles were added to RMGICs. Instead of micromechanical interaction, increased ionic bonding with a tooth was detected.

GICs impregnated with chlorhexidine released approximately 10 ppm of fluoride over the first 48 hours after being placed in the created cavity. Chlorhexidine digluconate can be added to it to boost its antibacterial properties[10-16].

Aside from contemporary composite and glass ionomer cements, there are several materials that we can fairly stately represent a future period of dental materials that are or will be employed in pediatric dentistry. Some of them are:

Silver Diamine Fluoride (SDF) is a fluoride liquid based on silver that is used to prevent caries from spreading by denaturing and breaking down microorganisms in the affected region. SDF is used as a complement to restorative care due to its ability to enter dentinal tubules and reduce pain in deep lesions when applied in indirect pulp therapy. When taken alone, SDF has the capacity to arrest incipient lesions. Arresting these lesions in young children who are unable to comply in a conventional dental setting has the potential to eliminate the need for treatment under general anaesthetic or restorative procedures[17].

Active bioactive restoratives: Bioactive materials that operate well in a moist oral environment, neutralize factors that cause tooth decay, provide preventive advantages, and maximize remineralization potential. ACTIVA™ the first dental resin containing a shock-absorbing rubberized resin component, reactive ionomer glass fillers, and a bioactive ionic resin matrix. Bioactive products imitate the physical and chemical qualities of real teeth.

Bioaktivni materijali: Bioaktivni materijali koji dobro funkcionišu u vlažnom oralnom okruženju neutrališu faktore koji uzrokuju karijes, pružaju preventivne prednosti i dovode do maksimuma potencijala remineralizacije. ACTIVA™ je prva stomatološka smola koja sadrži komponentu gumirane smole, punila od reaktivnog jonomernog stakla i bioaktivnu jonsku smolu. Bioaktivni proizvodi imitiraju fizičke i hemijske kvalitete pravih zuba. Uključujući se u cikluse jonske razmene, ovi materijali aktivno učestvuju u upravljanju prirodnom hemijom naših zuba i pljuvačke, čime pomažu u očuvanju oralnog zdravlja i strukture zuba[18].

Cention N: Tečnost *Cention N* sastoji se od četiri monomera koja se obično nalaze u smolastim kompozitima. S obzirom na to da mu nedostaju kiseli monomeri i voda, od samog početka izostaje sposobnost adhezije (proizvođač to signalizira lepkom u šupljinama koje se ne zadržavaju). Tečnost takođe sadrži aktivatore fotopolimerizacije i fotopolimerizatore, što je potencijalno čini pravim materijalom za punjenje. Njenu osobenost čini sastav praha ovog materijala, posebno reaktivna punila koja sadrži. Ovaj proizvod kombinacija je praha i tečnosti koja se mora ručno mešati spatulom. Poput giomera i kompomera, *Cention N* emituje jone, pre svega fluor, kada se unese u oralnu sredinu, naročito onu koja je kisela[19,20].

Surefil One prvenstveno se sastoji od poliakrilne kiseline visoke molekularne težine funkcionalizovane sa grupama koje mogu da se polimerizuju – kompanija ih naziva „modifikovani sistem polikiselina" (MOPOS). U pogledu strukture, ova poliakrilna kiselina slična je *Vitrebond* kopolimeru koji se nalazi u *Vitremeru* i *Ketac Nano*. Štaviše, tečnost sadrži monomere sa dva fotopolimerizujuća kraja koja deluju kao unakrsni vezivač između funkcionalizovanih lanaca poliakrilne kiseline. Naposletku, smesa uključuje hemikalije za fotopolimerizaciju i hemopolimerizaciju, kao i malo vode. U principu, ovaj materijal prava je supstanca za punjenje, budući da dolazi u obliku kapsule za jednokratnu upotrebu koja se mora mehanički protresti pre upotrebe. *Surefil One* je neobičan po tome što ga je proizvođač odobrio za upotrebu u svim vrstama restauracija[21].

Detection and diagnosis of dental caries

Ako se rano otkrije i dijagnostikuje, zubni karijes se lakše i jeftinije leči. Takođe, potrebno je manje vremena za obnovu zuba.

By engaging in ionic exchange cycles, these materials actively participate in the management of the natural chemistry of our teeth and saliva. As a result, they aid in the preservation of oral health and tooth structure[18].

Cention N: The liquid of *Cention N* is composed of four monomers that are commonly found in resin composites. It lacks acidic monomers and water; therefore, it lacks adhesive capability from the start (the maker signals this with an adhesive in non-retentive cavities). The liquid also contains photopolymerization and photopolymerization activators, making it potentially a true bulk-fill material. This material's powder composition, particularly the reactive fillers it includes, is its distinctive feature. This product is a powder-liquid combination that must be spatulated by hand. *Cention N*, like giomers and compomers, emits ions, most notably fluoride, when introduced into the oral environment, particularly in an acidic environment[19,20].

Surefil One is primarily composed of a high molecular weight polyacrylic acid that has been functionalized with polymerizable groups, which the company refers to as the Modified Polyacid System (MOPOS). In terms of structure, this polyacrylic acid is similar to the *Vitrebond* copolymer found in *Vitremer and Ketac Nano*. Furthermore, the liquid contains monomers with two photo-polymerizable ends that act as a cross-linker between functionalized polyacrylic acid chains. Finally, the mixture includes photopolymerization and chemopoly-merization chemicals, as well as some water. In principle, this material is a real bulk-fill substance because it comes in the shape of a single-use capsule that must be mechanically vibrated before use. *Surefil One* is unusual in that it is approved by the manufacturer for use in all types of restorations[21].

Detection and diagnosis of dental caries

Dental caries is easier to treat, less expensive to treat, and takes less time to rebuild teeth if discovered and diagnosed early. It typically originates in the cracks on the occlusal surface of the tooth. The major instruments utilized in traditional examination for caries detection are visual inspection, tactile sensation, and radiography. While these methods are useful for detecting cavitated lesions, they are typically insufficient for detecting early lesions. As a consequence of these deficiencies, new detection techniques have been developed to aid in improved

Obično nastaje u fisurama okluzalnih površina zuba. Glavne metode koje se koriste u tradicionalnoj dijagnostici karijesa jesu vizuelna inspekcija, taktilni osećaj i radiografija. Iako su ove metode korisne za otkrivanje kavitacija, obično nisu dovoljne za otkrivanje početnih lezija. S ciljem da se otklone ovi nedostaci, razvijene su nove tehnike detekcije koje olakšavaju dijagnozu. Bez obzira na savremene metode dijagnostikovanja karijesa, pregledi usne duplje i vizuelni pregledi najbolji su način da se identifikuju sumnjive lezije. Međutim, postoji niz dostupnih aktuelnih dijagnostičkih procedura i tehnika koje mogu otkriti čak i najsitnije promene u zubnom tkivu[22].

Radiografija

Radiografija je veoma korisna u detekciji karijesnih lezija, posebno onda kada one nisu klinički vidljive. Zbog upotrebe fluorida, ne dolazi do pucanja površine gleđi kod pacijenata sa malo karijesa, što otežava dijagnozu karijesa. Prevalencija takvih lezija naglo je porasla poslednjih godina[23]. Studije su pokazale da je radiografija sa nagriznim krilcem efikasan pristup za otkrivanje aproksimalnog i skrivenog karijesa[24].

Digitalna radiografija

Stomatolozi uveliko koriste digitalne stomatološke rendgenske snimke (digitalne rendgenske snimke) za identifikaciju i dijagnozu oralnih problema i bolesti, kao i tokom lečenja i praćenja bolesti. Digitalna radiografija predstavlja oblik rendgenskog snimanja koji zamenjuje standardni fotografski rendgenski film digitalnim rendgenskim senzorima s ciljem da se obezbede poboljšane kompjuterske slike zuba, desni i drugih oralnih struktura i bolesti. Digitalne dentalne slike dobijaju se pomoću jedne od triju metoda: direktne, indirektne ili poluindirektne. Direktna tehnika snima slike pomoću elektronskog senzora postavljenog u usta. Indirektni pristup koristi skener rendgenskog filma za generisanje digitalnih slika tipičnih rendgenskih snimaka zuba. Za pretvaranje zubnih rendgenskih zraka u digitalni film poluindirektni digitalni pristup upotrebljava senzor i skener. Tipovi ekstraoralnih rendgenskih zraka uključuju panoramske rendgenske snimke (Panorex), kompjutersku tomografiju sa više preseka (MCT), cefalometrijske projekcije i sijalografiju.

there is a pronounced disruption of the sutural articulation of the maxilla to the remaining nine bones of the craniofacial complex, enabling a reaction to the forces of protraction[22].

Radiography

Radiography is quite useful in finding caries lesions, especially when they are not clinically evident. Because of fluoride usage, the surface of enamel does not break down in low caries populations, making caries diagnosis more difficult. The prevalence of such lesions has skyrocketed in recent years[23]. Bitewing radiography has been shown in trials to be an efficient approach for detecting proximal and concealed caries[24].

Digital radiography

Digital dental radiographs (digital X-rays) are rapidly being used by dental practitioners to identify, diagnose, treat, and monitor oral problems and illnesses. Digital radiography is a form of X-ray imaging that replaces standard photographic X-ray film with digital X-ray sensors to provide improved computer pictures of teeth, gums, and other oral structures and diseases. Digital dental pictures are obtained using one of three methods: direct, indirect, or semi-indirect. The direct technique records pictures using an electronic sensor implanted in the mouth. The indirect approach uses an X-ray film scanner to generate digital pictures of typical dental X-rays. To convert dental X-rays into digital film, the semi-indirect digital approach includes a sensor and scanner. Types of extraoral X-rays include Panoramic (Panorex) X-rays, MCT (multi-slice computed tomography), Cephalometric projections, and Sialography.

Digital subtraction radiography (DSR)

Subtraction radiography improves the visibility of radiographic changes between two radiographs by removing unchanging backdrop disturbances. Subtraction was first accomplished in angiography by utilizing positive and negative prints. DSR has improved significantly in the identification of oral and maxillofacial lesions. This technology is employed in periodontal diagnostics because it has the capacity to identify bone alterations by as little as 1%. Another application of DSR is in the imaging of the temporomandibular joint (TMJ), particularly with panoramic. TMJ imaging programs permitted imaging of the

Digitalna suptrakciona radiografija

Suptrakciona radiografija poboljšava vidljivost radiografskih promena između dvaju radiografa tako što uklanja nepromenljive smetnje u pozadini. Suptrakcija je najpre postignuta u angiografiji korišćenjem pozitivnih i negativnih otisaka. Digitalna suptrakciona radiografija (DSR) značajno je poboljšana u identifikaciji oralnih i maksilofacijalnih lezija. Ova tehnologija koristi se u parodontološkoj dijagnostici pošto ima kapacitet da identifikuje koštane promene za samo 1%. DSR se primenjuje i u snimanju temporomandibularnog zgloba (TMZ), posebno sa panoramskim snimcima. Programi snimanja TMZ-a dozvoljavaju snimanje desnih i levih kondila donje vilice u otvorenim i zatvorenim pozicijama na jednom filmu. Međutim, glava kondila i intraartikularni prostor nisu jasno prikazani zbog superponiranja okolnih struktura i kosih projekcija zgloba. DSR se takođe koristi za procenu napredovanja, zaustavljanja ili regresije kaustičnih lezija. Čini se da kontrast između dveju fotografija predstavljaju tamni i svetli delovi. Ova metoda se u velikoj meri koristi i u parodontologiji za identifikaciju karijesa i za merenje gubitka koštane mase[25,26].

Transiluminacija

Transiluminacija u stomatologiji prvi put je sagledana u knjizi dr Williama Johna Camerona „Dijagnostika transiluminacijom: Traktat o upotrebi transiluminacije u dijagnozi infektivnih stanja zubnog procesa" 1922. godine[27]. Transiluminacija je prenos svetlosti kroz biološka tkiva. Odličan je način detekcije karijesa, fraktura, ograničenih otvora kanala korena i drugih kliničkih karakteristika. Deluje tako što ispušta jarku svetlost kroz bočnu stranu zuba. Može pozitivno uticati na dijagnostičke i terapijske sposobnosti kliničara. Indeks propuštanja svetlosti zdravih zubnih struktura veći je od onog kod zuba zahvaćenih karijesom ili kamencem. Linija preloma ili kalcifikovani otvor kanala korena takođe mogu ograničiti prenos svetlosti. Naime, ako se jako svetlo usmerava direktno na zub dok je druga strana svetlosti prigušena, ove kliničke pojave prikazaće se kao diskretne crne mrlje u inače briljantnoj strukturi. Vrh transiluminatora stavlja se na oralnu ili lingvalnu površinu zuba ili korena, a regija se može videti sa okluzalne površine ili površine koja se nalazi suprotno od transiluminatora.

right and left mandibular condyles in open and closed positions on a single film, however, the condylar head and intra-articular space were not clearly displayed due to the superimposition of surrounding structures and the joint's oblique projection. DSR has also been used to assess the advancement, stop, or regression of caustic lesions. The contrast between the two photographs appears to be dark and bright parts. This method is also widely used in periodontology for the identification of caries and the measurement of bone loss[25,26].

Transillumination

Transillumination in dentistry was first discussed in Dr. William John Cameron's book "Diagnosis by Transillumination: A Treatise on the Use of Transillumination in the Diagnosis of Infectious Conditions of the Dental Process" in 1922[27]. Transillumination is the transmission of light through biological tissues. Transillumination is a great way to see caries, fractures, restricted root canal orifices, and other clinical features. It works by shining a bright light through the side of the tooth and can significantly improve the clinician's diagnostic and treatment abilities. The index of light transmission of healthy dental structures is higher than that of caries or calculus. A fracture line or calcified root canal opening can also limit light transmission. As a result, if a strong light is shone directly on a tooth while other extraneous light is dimmed, these clinical entities will show as discrete black patches in an otherwise brilliant structure. The transilluminator tip is put on the tooth's or root's facial or lingual surface, and the region may be seen from the occlusal surface or the surface opposite the transilluminator. Depending on the region under inspection, direct eyesight or a dental mirror may be utilized for viewing. For cavities, endodontics, fractures, and so on, the exact positioning of the transilluminator varies. Transillumination's popularity as a diagnostic procedure has been considerably aided by the availability of sophisticated instruments designed specifically for this purpose. To provide the required bright white light, these transilluminators employ white light-emitting diode (LED) lamps. The light is then transferred without heat to the working area through a thin fibre-optic rod or fibre-optic wires. A crucial aspect is an ease with which a fibre-optic rod may be withdrawn and autoclaved to prevent cross-contamination between patients. The new gadgets' modest size and mobility make transillumination more practical to use.

U zavisnosti od regije koja se pregleda, promena se može posmatrati direktno ili stomatološkim ogledalom. Kada je reč o karijesu, endodonciji, frakturama i sl., tačno pozicioniranje transiluminatora varira. Popularnost transiluminacije kao dijagnostičke procedure umnogome je potpomognuta dostupnošću sofisticiranih instrumenata dizajniranih posebno u ove svrhe. Da bi obezbedili potrebno jarkobelo svetlo, ovi transiluminatori koriste bele svetleće diode (engl. *light-emitting diode* – LED). Svetlost se zatim bez toplote prenosi na radni prostor kroz tanku šipku od optičkih vlakana ili kroz optičke žice. Ključni faktor predstavlja lakoća sa kojom se fiberoptički štap može izvući i autoklavirati kako bi se sprečila kontaminacija među pacijentima. Skromna veličina i mobilnost novih uređaja čine transiluminaciju praktičnijom za upotrebu.

Fiberoptička detekcija

Svi oblici transiluminacije korišćenjem optičkih vlakana zasnivaju se na konceptu koji podrazumeva da se svetlost širi kroz optička vlakna od izvora svetlosti do zuba i da mora biti dovoljno svetla da pređe strukturu zuba. Transiluminacija optičkim vlaknima koristi se kao pomoćna dijagnostička procedura u dijagnostici prednjeg i zadnjeg inter-proksimalnog karijesa i okluzalnog karijesa, za otkrivanje kamenca, u proceni obojenih ivica kompozitnih smola, u proceni preloma kvržice i infrakcija zuba, kao alat za istraživanje za osvetljavanje endodontskog pristupa i otvora kanala korena u pulpnoj komori zuba u toku endodontskog tretmana, kao sredstvo poboljšanja procene otvora kanala korena u toku endodontskog lečenja, u proceni keramičkih restauracija kako bi se isključilo postojanje bilo kakvih preloma pre cementiranja, za kliničko ispitivanje linija loma i nabora na potpuno keramičkim restauracijama i prirodnim zubima, te za određivanje odgovarajućih preporuka za lečenje na osnovu nivoa spoljašnjeg bojenja. Metode koje koriste ovaj moćni izvor svetlosti poznate su kao FOTI (engl. *fiber-optic transillumination*) i digitalna slikovna optička transiluminacija (eng. *digital imaging fibre-optic transillumination*-DIFOTI). Putanja bliskog infracrvenog svetlosnog snopa u DIFOTI-ju razlikuje se između zvuka i povređenog tkiva. Nalazi se mogu sačuvati kao digitalne fotografije i prikazati na monitoru uz korišćenje DIFOTI-ja Vlakna usmeravaju svetlost na površinu zuba, a zub se sa obeju strana osvetljava vrhom ili senzorom koji se nalazi u plastičnom rukohvatu uređaja.

Fibre Optics Detection

Transillumination using fibre optics in all of its forms is based on the concept that light propagates through optical fibres from a light source to the tooth and must be bright enough to cross tooth structure. Fibre-optic transillumination is used as an adjunctive diagnostic aid for anterior and posterior interproximal caries and occlusal caries diagnosis; detection of calculus; evaluation of stained margins of composite resins; evaluation of cusp fractures and cracked teeth; as an exploration tool to illuminate endodontic access and root canal orifices within the pulp chamber of teeth during endodontic treatment; as a tool for improved evaluation of root canal orifices during endodontic treatment; for evaluating all-ceramic restorations to rule out any fractures before to cementation; for clinical examination of fracture and craze lines in all-ceramic restorations and natural teeth; and for determining suitable treatment recommendations based on the level of extrinsic staining. Methods utilizing this powerful light source are known as FOTI (fibre-optic transillumination) and digital imaging fibre-optic transillumination (DIFOTI). The path of the near-infrared light beam in DIFOTI differs between sound and injured tissue. The findings may be saved as digital photos and presented on a monitor using DIFOTI. Fibres guide the light onto the tooth surface, and the tooth is transilluminated from both sides by a tip or a sensor in the device's plastic handgrip. A small camera is built into the tip, and a digital image of the tooth is relayed to a monitor online. Images captured can be preserved in the database[28-32].

The Microlux Transilluminator® (Addent, Danbury, CT) detects anterior and posterior caries. It also aids in the visualization of crown fractures, root canal orifices, and root fractures without the requirement for X-rays. A simple push-button controls the dual-intensity operation and improves vision. The battery features a low-level indication, and the device contains a voltage regulator to provide consistent light output. It runs on two readily accessible AAA batteries. The Microlux 2 comes with a 2mm or 3mm light guide and accommodates all existing Microlux autoclavable accessories[33].

DEXIS CariVu^{TM} is a small, portable caries diagnostic equipment that uses proprietary transillumination technology to help identify occlusal, interproximal, and recurring carious lesions and fractures. CariVu continues DEXIS' long legacy of offering straightforward, user-friendly diagnostic tools to the dentistry community[34].

Mala kamera ugrađena je u vrh, a digitalna slika zuba prenosi se na monitor na mreži. Snimljene slike mogu se sačuvati u bazi podataka[28-32].

The Microlux Transilluminator® (Addent, Danburi, CT) otkriva prednji i bočni karijes. Takođe pomaže u vizuelizaciji preloma krunice, otvora kanala korena i fraktura korena, i to bez potrebe za rendgenskim snimcima. Jednostavno dugme kontroliše rad dvostrukog intenziteta i poboljšava vid. Baterija ima indikaciju niskog nivoa, a uređaj sadrži regulator napona koji obezbeđuje konzistentan izlaz svetlosti. Koriste se dve lako dostupne AAA baterije. *Microlux 2* dolazi sa svetlosnim vodičem od 2 mm ili 3 mm i prihvata svu postojeću *Microlux* dodatnu opremu za autoklaviranje[33].

DEXIS CariVu™ je mala, prenosiva oprema za dijagnostiku karijesa koja koristi sopstvenu tehnologiju transiluminacije kako bi pomogla u identifikaciji okluzalnih, interproksimalnih i recidivirajućih karijesnih lezija i preloma. *CariVu* nastavlja dugu zaostavštinu *DEXIS* -a u ponudi jednostavnih dijagnostičkih alata lakih za upotrebu u stomatološkoj zajednici[34].

DIAGNOcam Vision Full HD® (KaVo, Biberach, Nemačka) pretvara zube u svetlosne provodioce korišćenjem bezbolnog lasera podešenog na određenu talasnu dužinu i uslovljava da bilo kakve lezije ili pukotine zaustave prirodni tok svetlosti, stvarajući senke na slici. Projektuje uživo zub na povezani monitor, pružajući stomatologu vođeni vizuelni pregled usne duplje. Ovaj proizvod prilično je delotvoran za otklanjanje problema kao što su rano otkrivanje karijesa okluzalnih, aproksimalnih i glatkih površina, sekundarnog karijesa i fraktura pre nego što se pojave komplikacije. *DIAGNOcam* pruža „tri u jedan" dijagnostiku pritiskom na dugme. Revolucionarna ideja „tri u jedan" proizvodi svetle, *Full HD* intraoralne, transiluminacione i fluorescentne slike. Dakle, tri klinički relevantne fotografije dobijaju se za manje od jedne sekunde i samo jednim klikom. Pored toga, korisnik može izabrati režim jedne fotografije ili kombinaciju dvaju ili triju režima za individualno optimizovani tok rada koji je idealan za proceduru tretmana[35].

Fluorescencija

Fluorescencija je vrsta foto-luminiscencije koju karakterišu apsorpcija objekta UV zračenja (od 1 nm do 400 nm nevidljive svetlosti) i spontana emisija dužih talasnih dužina (od 430 nm do 450 nm vidljive svetlosti).

DIAGNOcam Vision Full HD® (KaVo, Biberach, Germany) converts the teeth into a light conductor by using a painless laser tuned to a specific wavelength, causing any lesions or cracks to stop the natural flow of light, creating shadows in the imagery, and projects a live feed of teeth onto a connected monitor, providing the dentist with a guided visual tour of the mouth. This product is quite effective for catching problems like early detection of occlusal, approximal, smooth surfaces, secondary caries, and cracks before they grow too complicated. DIAGNOcam provides a three-in-one diagnostic with the stroke of a button. The revolutionary 3-in-1 idea produces bright, Full HD intraoral, transillumination, and fluorescence pictures. That is, three clinically relevant photos are created in less than a second and with only one click. In addition, the user can select a single photo mode or a combination of two or three modes for an individually optimized workflow that is ideal for the treatment procedure[35].

Fluorescence

Fluorescence is a type of photo-luminescence characterized by an object's absorption of UV radiation (1 nm to 400 nm invisible light) and spontaneous emission of longer wavelengths (430 nm to 450 nm visible light). Autofluorescence is the natural emission of light by biological structures when they absorb light, and it is used to differentiate light emission from fluorescent markers (fluorophores). The presence of endogenous fluorophores in the enamel and dentine accounts for tooth autofluorescence. Because of the energy difference, the colour of the emitted fluorescence light is always different from the colour of the excitation light, with a longer wavelength and lower photon energy. Thus, violet or blue excitation light will produce green, orange, or red emissions, all of which are longer wavelengths of visible light. It is generally known that the enamel and dentin both exhibit autofluorescence. Light absorption and reemission varies across enamel, dentin, and cementum, as well as between sound and carious tissues. As a result, fluorescence may be utilized to identify and further diagnose dental cavities. Fluorescent components can also be found in tooth plaque and oral bacteria. Aside from its use in caries detection and other tissue diagnostics, another important aspect of fluorescence revealed by the introduction of restorative materials into clinical dentistry is its relationship with the optical properties of teeth and the ability of said materials to reproduce it.

Autofluorescencija je prirodna emisija svetlosti bioloških struktura kada apsorbuju svetlost, a koristi se za razlikovanje emisije svetlosti od fluorescentnih markera (fluorofora). Prisustvo endogenih fluorofora u gleđi i dentinu objašnjava autofluorescenciju zuba. Zbog razlike u energiji, boja emitovane fluorescentne svetlosti uvek se razlikuje od boje ekscitacione svetlosti, sa dužom talasnom dužinom i manjom energijom fotona. Dakle, ljubičasta ili plava pobudna svetlost proizvešće zelenu, narandžastu ili crvenu emisiju, a sve su veće talasne dužine vidljive svetlosti. Opšte je poznato da i gleđ i dentin pokazuju autofluorescenciju. Apsorpcija i reemisija svetlosti variraju između gleđi, dentina i cementa, kao i između zdravih i karijesnih tkiva. Rezultat toga je da se fluorescencija može koristiti za identifikaciju i dalju dijagnozu kavitacija. Fluorescentne komponente takođe se mogu naći u zubnom plaku i oralnim bakterijama. Osim upotrebe u detekciji karijesa i dijagnostici oboljenja drugih tkiva, još jedan važan aspekt fluorescencije otkriven uvođenjem restaurativnih materijala u kliničku stomatološku praksu čini njen odnos sa optičkim svojstvima zuba i sposobnošću pomenutih materijala da je reprodukuju. U idealnoj situaciji, materijali za restauraciju treba da imaju nivo fluorescencije uporediv sa prirodnim zubima. To, nažalost, nije slučaj, čak ni kada je reč o savremenim stomatološkim materijalima koji pokazuju varijacije u emisiji fluorescencije. U stomatologiji se koristi laserska, ksenonska i LED oprema, koja emituje svetlost i radi na principima fluorescencije[30,36].

Uređaji koji emituju svetlost

Laser

Za otkrivanje karijesa mogu se koristiti različiti laserski zasnovani sistemi. Najčešći instrument za otkrivanje karijesa pomoću fluorescencije jeste laser. Fluorescencija normalne zdrave strukture zuba minimalna je ili nikakva. Karijesna struktura zuba fluorescira srazmerno obimu karijesa. Kada se primenjuje određena talasna dužina laserske svetlosti, nusprodukti bakterija poznati kao porfirini trepere crveno. Intenzitet fluorescencije stoga može biti određen kao direktna veza sa prisustvom i obimom aktivnosti karijesa. Dakle, što je veći atak kiseline na zub, to je veći broj na skali uređaja za detektovanje[37-40].

U ovoj oblasti dijagnostike pionir je bio *DIAGNOdent*® (KaVo, Biberach, Nemačka).

Restorative materials should ideally have fluorescence levels comparable to natural teeth; unfortunately, this is not the case, even with modern dental materials exhibiting variances in fluorescence emission. Laser, xenon, and LED light-emitting equipment is utilized in dentistry and works on the principles of fluorescence[30,36].

Light-emitting devices

Laser

There are a variety of laser-based systems available for detecting caries. The most often used instrument for detecting caries using fluorescence is a laser. Fluorescence from normal healthy tooth structure is minimal to non-existent. Carious tooth structure fluoresces in proportion to the extent of caries. When a certain wavelength of laser light is applied, bacterial byproducts known as porphyrins flash red. The fluorescence intensity may therefore be assessed as a direct link to the presence and extent of caries activity. As a result, the worse the acid assault on the tooth, the higher the number on the capture device's scale[37–40].

The DIAGNOdent® (KaVo, Biberach, Germany) was a pioneer in this diagnostic field. On a scale of 0 to 99, this portable gadget monitors fluorescence. Its effectiveness in assessing the presence and extent of the caries process is well documented, but there does not appear to be agreement on what number on the scale signals the point at which treatment should begin. Because the probe is so small, the DIAGNOdent can be technique-intensive. For large-coverage regions, such as a mandibular molar, several readings would have to be recorded by an assistant or the dentist for each pit or crack in the tooth[41].

The Canary System® (Quantum Dental Technologies Inc.)

The Canary System is a precise, low-powered laser-based instrument with an integrated intraoral camera that detects cracks and caries before they become large enough to show up on dental X-rays. Images from the intraoral camera can be shown for an instant chairside examination of the patient. A patient report is provided that includes an odontogram with color-coded Canary Numbers for the inspected teeth, as well as the dentist's treatment advice. The patient can also view this report on The Canary Cloud. During a three-second scan, a low-powered, pulsating laser light is shone on the tooth surface.

Ovaj prenosivi uređaj prati fluorescenciju na skali od 0 do 99. Njegova efikasnost u proceni prisustva i obima procesa karijesa dobro je dokumentovana, ali izgleda da nema saglasnosti u vezi sa tim koji broj na skali označava tačku kada treba započeti lečenje. Pošto je sonda vrlo mala, *DIAGNOdent* može zahtevati intenzivnu tehniku. Za regione sa velikom pokrivenošću, kao što je npr. mandibularni molar, asistent ili stomatolog morao bi snimiti nekoliko očitavanja za svako udubljenje ili svaku pukotinu na zubu[41].

The Canary System® (Quantum Dental Technologies Inc.)

The Canary System je precizan laserski instrument male snage sa integrisanom intraoralnom kamerom koja detektuje pukotine i karijes pre nego što postanu dovoljno veliki da se pojave na rendgenskim snimcima zuba. Slike sa intraoralne kamere mogu se u tom trenutku prikazati pacijentu. Obezbeđen je izveštaj pacijenta koji uključuje odontogram sa kodiranom bojom označenom *Canary* brojevima za pregledane zube, kao i savet stomatologa o mogućoj terapiji. Pacijent takođe može pogledati ovaj izveštaj na *Canary Cloudu*. Tokom skeniranja koje traje tri sekunde, pulsirajuća laserska svetlost male snage isijava na površinu zuba. Laserski svetlosni impulsi izazivaju fototermalne (PTR) i luminiscentne (LUM) reakcije. Korišćenjem laserskog impulsa na frekvenciji od 2 Hz lasersko svetlo može prodreti izvan površine zuba i identifikovati karijesne lezije koje imaju veličinu od čak 50 mikrona (što je dvadeset puta manje od milimetra) i koje se nalaze na čak 5 mm dubine od površine zuba. *Canary* broj generiše *Canary System* radi informisanja stomatologa o verovatnom zdravstvenom statusu određenog zuba. *Canary System* prevodi jedinstvene PTR/LUM potpise u *Canary* broj na skali od 0 do 100, koji se prikazuje na ekranu monitora, ali i čuje zahvaljujući komplikovanom algoritmu. Niže vrednosti ukazuju na dobru gleđ, a više vrednosti na postojanje pukotina i karijesa42.

LED fluorescentni uređaj

Tehnologija *Spectra Caries Detection*® (Air Techniques, Inc., Melville, N.I.) rešila je mnoge probleme izazvane upotrebom ranih tehnologija laserske fluorescencije. Pojavila se tehnologija koja je prenosiva, efikasna i ima značajan uticaj na pacijente, a pruža i odličnu dokumentaciju o stanju karijesa zuba.

Laser light pulses cause photothermal (PTR) and luminescence (LUM) reactions. The laser light can penetrate beyond the tooth surface and identify carious lesions as tiny as 50 microns (20 times smaller than a millimetre) and as deep as 5 mm from the tooth surface by utilizing a laser pulse at a frequency of 2Hz. A Canary Number is the output generated by The Canary System to inform an oral health care professional about the likely health status of a specific tooth. The Canary System translates the unique PTR/LUM signatures into a Canary Number on a scale of 0 to 100, which shows on a monitor screen and is also audible, using a complicated algorithm. Lower values indicate good enamel, whereas larger values indicate the existence of fissures and cavities[42].

LED fluorescence device

The Spectra Caries Detection technology® (Air Techniques, Inc., Melville, N.Y.) has addressed many of the concerns raised by early laser fluorescence technologies, resulting in a technology that is portable, efficient, and delivers considerable patient impact as well as great documentation of the tooth's caries condition. It comprises a wand that, through a TWAIN interface, smoothly connects with most digital imaging applications. This "plug-and-play" feature enables the user to rapidly unplug the device from one computer and attach it to another. The Spectra capture a single image of the tooth and map the fluorescence in various hues based on its intensity. Furthermore, a patented algorithm condenses the scale from 0 to 3, making analysis and decision-making easier. As a result, a value of 1 shows that acid has attacked the enamel. If one believes in early intervention, that region is in high danger of deeper degradation and should thus be examined and sealed. The inspection can be photographed against the same teeth as typical intraoral pictures and saved in the digital record for simple memory, or it can be printed for insurance companies and patients[43,44].

VistaProof® (Dürr Dental, Bietigheim-Bissingen, Germany)

The gadget works on the same premise of enhanced fluorescence in carious lesions as Diagnodent® but uses a different wavelength of excitation. It allows the practitioner to save and retain photographs of occlusal surfaces examined by the program, which indicates the regions of teeth that release a high amount of fluorescence.

Sastoji se od štapića koji se preko TVAIN interfejsa glatko povezuje sa većinom aplikacija za digitalno snimanje. Ova *plug-and-play* funkcija omogućava korisniku da brzo isključi uređaj sa jednog računara i priključi ga na drugi. *Spectra* snima jednu sliku zuba i mapira fluorescenciju u različitim nijansama na osnovu njenog intenziteta. Štaviše, patentirani algoritam sažima skalu od 0 do 3, što olakšava analizu i donošenje odluka. Vrednost 1 pokazuje da je reč o ataku kiseline na gleđ. Za one koji veruju u ranu intervenciju, ta regija je u velikoj opasnosti od dublje razgradnje i zato je treba ispitati i zaliti. Inspekcija se može fotografisati naspram istih zuba kao tipične intraoralne slike i sačuvati u digitalnom zapisu radi jednostavnog pamćenja ili se može odštampati za osiguravajuća društva i pacijente[43,44].

VistaProof® (Dürr Dental, Bietigheim-Bissingen, Germany)

Uređaj radi na istoj pretpostavci poboljšane fluorescencije karijesnih lezija kao *DIAGNOdent®,* ali koristi drugačiju talasnu dužinu ekscitacije. Omogućava lekaru da sačuva i zadrži fotografije okluzalnih površina koje su pregledane programom, što ukazuje na regione zuba koji oslobađaju veliku količinu fluorescencije. Ovom tehnikom snimaju se slike zuba, koje se zatim procenjuju softverom i čuvaju na računaru. *VistaProof®* koristi svetlo talasne dužine od 405 nm i softver koji pojačava fluorescenciju koju oslobađa tkivo. Softver za gledanje (*Dürr Dental*) koristi se za digitalizaciju video-toka, proizvodeći slike rezolucije 720 k 576 piksela, 3 k 8-bit RGB dubine boje i 72 piksela po inču (rezolucija ekrana računara). Program analizira fotografije i kvantifikuje crvene i zelene komponente fluorescencije. Program prikazuje intenzitet fluorescencije u veštačkim nijansama na osnovu tabele za traženje (LUT) u rasponu od zelene (*510 nm talasne dužine) do crvene (*680 nm talasne dužine). Vrednost rezultata, koja se kreće od 0 do 3, odnosi se na težinu lezije i ukazuje na odnos intenziteta crvene i zelene fluorescencije. Kada pređu vrednosti od 2,0, karijesne lezije dostižu dentin, što VistaProof na ekranu prikazuje kao narandžastu ili žutu oblast[45,46].

D-Carie mini™ (Neks Technologies Inc.)

Mini-D koristi LED tehnologiju i tehnologiju optičkih vlakana za identifikaciju okluzalnih i aproksimalnih karijesnih lezija.

Images of the teeth are captured using this technique, then evaluated by software and saved on the computer. VistaProof® employs a 405 nm wavelength light and software that amplifies the fluorescence released by the tissue. A viewer software (Durr Dental) is used to digitize the video stream, producing pictures with 720 x 576 pixels of resolution, 3 x 8-bit RGB colour depth, and 72 pixels per inch (computer screen resolution). The program analyzes the photos and quantifies the red and green components of fluorescence. The program displays the fluorescence intensity in artificial hues based on a look-up table (LUT) ranging from green (*510 nm wavelength) to red (*680 nm wavelength). The result value, which ranges from 0 to 3, refers to the severity of the lesion and indicates the intensity ratio of red and green fluorescence. When values exceed 2.0, carious lesions reach the dentin, which VistaProof depicts as an orange or yellow area on the screen[45,46].

D-Carie mini™ (Neks Technologies, Inc.)

Mini-D uses LED and fibre-optic technologies to identify occlusal and proximal caries lesions. This device creates 635−880 nm LED light, analyzes the light reflected off the surface of the tooth, and converts it into electrical impulses. It is simple to use because no calibration or difficult interpretation is required. Caries detection relies on structural changes in a tooth rather than the quantity of bacterial fluorescence present within pits and fissures. When used in combination with an X-ray, it enables the assessment of a third dimension—the volume of caries—prior to opening the tooth. The technology also enables the examination and diagnosis of children, pregnant women, and patients who choose to avoid or limit their exposure to X-rays for health or personal reasons[47,48].

Soprolife® (Acteon Imaging, La Ciotat, France) is a light-induced fluorescence intraoral camera system. Soprolife® uses two types of LEDs to illuminate the tooth and evaluate changes in mineral density. Images can be captured in three different modes: daylight, diagnosis, and treatment. The daylight mode uses a high-level magnification intraoral camera illuminated with white LEDs. The diagnosis and treatment modes use fluorescence via four blue LEDs at a 450 nm wavelength. The second light is directed at the tooth surface and produces a superimposed image over the white light image, a phenomenon known as autofluorescence. Soprolife uses a colour-coding system.

Ovaj uređaj stvara LED svetlo od 635 nm do 880 nm, analizira svetlost reflektovanu od površine zuba i pretvara je u električne impulse. Jednostavan je za upotrebu pošto nisu potrebni ni kalibracija ni teško tumačenje. Detekcija karijesa oslanja se na strukturne promene u zubu, a ne na količinu bakterijske fluorescencije prisutne u jamicama i fisurama. Kada se koristi u kombinaciji sa rendgenskim snimkom, omogućava procenu treće dimenzije – zapremine karijesa – pre otvaranja lezije. Ova tehnologija takođe omogućava pregled i dijagnostiku dece, trudnica i pacijenata koji iz zdravstvenih ili ličnih razloga odlučuju da izbegnu ili ograniče svoje izlaganje rendgenskim zracima[47,48].

Soprolife® (Acteon Imaging, La Ciotat, Francuska) predstavlja svetlo-indukovanu fluorescentnu intraoralnu kameru. *Soprolife*® koristi dve vrste LED dioda za osvetljavanje zuba i procenu promena u mineralnoj gustini. Slike se mogu snimiti u tri različita režima – jedan je dnevno svetlo, drugi dijagnoza, a treći lečenje. Režim dnevnog svetla koristi intraoralnu kameru visokog nivoa uvećanja osvetljenu belim LED diodama. Režimi dijagnoze i lečenja koriste fluorescenciju preko četiri plave LED diode na talasnoj dužini od 450 nm. Drugo svetlo je usmereno na površinu zuba i proizvodi sliku postavljenu iznad slike bele svetlosti, što je fenomen poznat kao autofluorescencija. *Soprolife* koristi sistem kodiranja boja. Zelena fluorescencija smatra se indikatorom zdravih tkiva, a crvena fluorescencija ukazuje na karijesnu leziju. Režim tretmana može se koristiti kao vodič u toku pripreme kaviteta. Slike se mogu sačuvati za buduća poređenja[26,49].

Kvantitativno svetlosno indukovana fluorescencija (engl. Quantitative light-induced fluorescence – QLF) prvi put je predstavljena 1995. godine. Ovo je optička metoda koja koristi prirodnu fluorescenciju zuba za razlikovanje karijesa od zdrave gleđi. Sjaj fluorescencije karijesnog tkiva koji se ispituje QLF-om niži je nego kod okolne zdrave gleđi. QLF određuje količinu minerala izgubljenu tokom demineralizacije izračunavanjem procentualne promene u osvetljenosti fluorescencije demineralizovane gleđi u poređenju sa okolnom zdravom gleđi. Svetlost se mnogo brže rasipa u karijesnim tkivima nego u zdravim zubnim tkivima, skraćujući put svetlosti u leziji i smanjujući apsorpciju i fluorescenciju u ovoj oblasti. To znači da se rasejanje svetlosti koristi za procenu gubitka minerala u vezi sa lezijom. QLF metoda takođe se može koristiti pri merenju crvene fluorescencije mikroorganizama u plaku.

Green fluorescence is considered an indicator of healthy tissues, and red fluorescence indicates a carious lesion. The treatment mode can be used as a guide during cavity preparation. Images can be saved for future comparisons[26,49].

Quantitative light-induced fluorescence (QLF) was first introduced in 1995. This is an optical method that leverages the natural fluorescence of teeth to distinguish between caries and sound enamel. The fluorescence radiance of a carious patch examined with QLF is lower than that of surrounding sound enamel. QLF calculates the quantity of mineral lost during demineralization by calculating the percentage change in fluorescence brightness of demineralized enamel compared to surrounding sound enamel. The light scatters much faster in carious tissues compared to sound dental tissues, shortening the pathway of the light in the lesion and decreasing the absorption and fluorescence in this area. This means that the scattering of the light is used for evaluating the mineral loss related to the lesion. The QLF method can also be used in measuring the red fluorescence from microorganisms in plaque. It works on the concept that distinct (organic) compounds in the mouth absorb light of a specific wavelength and then re-emit the absorbed energy at a different wavelength. A fluorescent or QLF picture is obtained by filtering the lighting light. Demineralized regions (e.g., white dots) appear as black patches in these pictures, and a decrease in fluorescence correlates with mineral loss. Porphyrin-covered areas, produced by (anaerobic) cariogenic bacterial activity, are bright red/orange. These impacts may be seen visually, analyzed and measured by proprietary software, and digitally documented[50,51].

Inspektor Pro™ (Inspektor™ Research, Amsterdam, Netherlands) was the first commercial QLF device marketed in 2004 which is a gadget for assessing oral cleanliness at home or at the dental clinic. The Inspektor Biluminator emits a harmless blue light that is used to detect porphyrins (byproducts of certain strains of anaerobic bacteria's metabolic process) in the oral cavity, especially inside or around tooth elements and the gingiva. These porphyrins cannot be seen with the naked eye. QLF has been utilized effectively for the past 12 years to identify and quantify demineralization and remineralization of tooth tissue and bacterial cavities. The Inspektor Biluminator improves the identification of white spot lesions, approximal caries, occlusal caries, margin leakage and secondary caries, sealant integrity, calculus, and gingivitis with

Bazira se na konceptu koji podrazumeva da različita (organska) jedinjenja u ustima apsorbuju svetlost određene talasne dužine, a zatim ponovo emituju apsorbovanu energiju na drugoj talasnoj dužini. Fluorescentna ili QLF slika dobija se filtriranjem svetla. Demineralizovani regioni (npr. bele tačke) pojavljuju se kao crne mrlje na ovim slikama, a smanjenje fluorescencije korelira sa gubitkom minerala. Područja pokrivena porfirinom, proizvedena (anaerobnom) kariogenom aktivnošću bakterija, svetlocrvene su ili narandžaste boje. Ovi uticaji mogu se prikazati vizuelno, analizirati i izmeriti vlasničkim softverom i digitalno dokumentovati[50,51].

Inspektor Pro™ (Inspektor™ Research, Amsterdam, Holandija) bio je prvi komercijalni QLF uređaj. Na tržištu je prisutan od 2004. godine, a služi za procenu oralne čistoće u kućnim uslovima ili u stomatološkoj klinici. *Inspektor Biluminator* emituje bezopasno plavo svetlo koje se koristi za otkrivanje porfirina (nusproizvoda određenih sojeva metaboličkog procesa anaerobnih bakterija) u usnoj duplji, posebno unutar zubnih tkiva i gingive ili oko njih. Ovi porfirini ne mogu se videti golim okom. QLF se poslednjih 12 godina efikasno koristi za identifikaciju i kvantifikaciju demineralizacije i remineralizacije zubnog tkiva i bakterijskih šupljina. *Inspektor Biluminator* olakšava identifikaciju početne lezije – bele mrlje, aproksimalnog karijesa, okluzalnog karijesa, curenja ruba i sekundarnog karijesa, integriteta zalivača, kamenca i gingivitisa. Za njegovu upotrebu nije potrebno ni mnogo finansijskih sredstava ni mnogo vremena. Koristi svetlosnu kutiju koja sadrži plavo-zelenu lampu sa talasnim dužinama od 290 nm do 450 nm, sa vršnim intenzitetom od 370 nm. Ekscitaciono svetlo putuje do intraoralnog štapića pomoću optičkog kabla. Štapić takođe sadrži kameru sa napunjenim uređajem (CCD) prekrivenu propusnim plavim filterom.

Ista kompanija predstavila je 2012. godine noviji QLF uređaj pod nazivom *QLF-D Biluminator 2* (Inspektor™ Research). Oba pomenuta uređaja osvetljavaju zube plavom svetlošću, što dovodi do toga da oni trepere zeleno (to je fenomen poznat kao autofluorescencija). Osim zelene autofluorescencije, plava svetlost može proizvesti i crvenu fluorescenciju. Smatra se da ovaj crveni sjaj stvaraju porfirini proizvedeni metaboličkim procesima određenih bakterijskih sojeva. Pokazalo se da je intenzitet crvene fluorescencije povezan sa aktivnošću bakterija.

little financial or time commitment. It utilizes a light box that contains a blue-green arc lamp with wavelengths of 290 nm to 450 nm with a peak intensity of 370 nm. The excitation light travels to an intraoral wand by fibre optic cable. The wand also contains a charged coupled device (CCD) camera covered with a bandpass blue filter.

In 2012, a newer QLF device was released by the same company under the name QLF-D Biluminator 2 (Inspektor™ Research). Both of these gadgets illuminate the teeth with blue light. This causes the teeth to flash green (a phenomenon known as autofluorescence). Aside from green autofluorescence, blue light can also produce red fluorescence. This red glow is thought to be created by porphyrins produced by particular bacterial strains' metabolic processes. It has been demonstrated that the intensity of the red fluorescence is connected to the activity of the bacteria. In addition to caries-related bacteria, several recent QLF research has revealed that red fluorescence may be linked to other oral health concerns such as gingivitis and halitosis. The capacity to track tooth surfaces over time (longitudinal monitoring) is a major feature of QLF. The program incorporates automated video repositioning, which allows for the capture of comparative QLF pictures of the same surfaces at various time intervals[52–55].

In addition to biluminators, the most recent capturing devices are available on the market.

For professionals and researchers, the *Q-Raycam*™ Pro is the gadget of choice. It is an intra-oral camera with the ability to zoom in on individual tooth surfaces. Offering an objective, longitudinal, quantitative oral health evaluation method, improving service quality, and helping the development of patient-centred preventative care programs are all advantages for dentists. Qraycam Pro is a high-resolution camera with an elegant and practical design that is lightweight, easy to use, and autofocus. Suitable for clinical and in vitro research. It contains an autosave function for white light and QLF™ photographs, full arch imaging, PMS compatibility, and a one-touch autofocus button. It also had anterior and occlusal modes, as well as PC or tablet apps, and the ergonomic grip design aided operation. *Qraypen C* is a portable intraoral diagnostic imaging gadget with autozoom capability. Quick capture of QLF™ and white light photos. Ideal for inspecting and diagnosing individual cracks, incipient and proximal caries, fissures, and plaque. It is compatible with PMS and has a one-touch imaging button.

Nekoliko nedavnih istraživanja QLF sistema otkrilo je da se crvena fluorescencija ne javlja samo kod bakterija povezanih sa karijesom već da može biti dovedena u vezu i sa drugim problemima oralnog zdravlja, kao što su npr. gingivitis i halitoza. Kapacitet praćenja površine zuba u toku vremena (longitudinalno praćenje) glavna je odlika QLF-a. Program uključuje automatizovano video-repozicioniranje, koje omogućava snimanje uporednih QLF slika istih površina u različitim vremenskim intervalima[52-55].

Pored biluminatora, na tržištu su dostupni i najnoviji uređaji za snimanje.

Q-Raycam™ Pro uređaj je koji uglavnom biraju profesionalci i istraživači. To je intraoralna kamera koja može zumirati pojedinačne površine zuba. Pružanje objektivne, longitudinalne, kvantitativne metode procene oralnog zdravlja, poboljšanje kvaliteta usluge i pomoć u razvoju programa preventivne nege usmerenih na pacijenta prednosti su za stomatologe. *Q-Raycam™* Pro je kamera visoke rezolucije sa elegantnim i praktičnim dizajnom. Lagana je, jednostavna za upotrebu i ima autofokus. Pogodna je za klinička i *in vitro* istraživanja. Sadrži funkciju automatskog čuvanja za belo svetlo i QLF™ fotografije, snimanje punog luka, PMS kompatibilnost i dugme za automatsko fokusiranje jednim dodirom. Ima i prednji i okluzalni režim, kao i aplikacije za računar ili tablet. Ergonomski dizajn ručke pomaže u radu. *Qraypen C* je prenosivi uređaj za intraoralno dijagnostičko snimanje, sa mogućnošću automatskog zumiranja. Brzo snima QLF™ fotografije i fotografije belog svetla. Idealan je za pregled i dijagnostiku pojedinačnih fisura, početnih i aproksimalnih karijesa, fisura i plaka. Kompatibilan je sa PMS-om i ima dugme za snimanje jednim dodirom. *Qscan Plus* je jednostavan i siguran Biofilm samotester, kao i odličan asistent za praćenje oralne higijene. Štitnik od ambijentalnog svetla osigurava jasan i svetao vid. Zreli kariogeni zubni plak prikazuje se zahvaljujući revolucionarnoj kombinaciji četiri fluorescentne LED diode i Inspektor filtera[56].

Endoskopija

Ovaj pristup oslanja se na ideju merenja fluorescencije koja se dešava kada su tkiva izložena plavoj svetlosti od 400 nm do 500 nm. Lezije bele mrlje izgledaju tamnije od zdrave gleđi kada se fluorescentna struktura zuba pregleda korišćenjem određenog želatinskog filtera.

Qscan Plus is a simple and safe biofilm self-tester as well as an excellent oral hygiene monitoring assistant. The ambient light shield ensures that the vision is clear and bright. Mature cariogenic dental plaque is shown by a revolutionary combination of four fluorescent LEDs and the Inspektor filter[56].

Endoscopy

This approach relies on the idea of measuring the fluorescence that happens when tissues are exposed to 400−500 nm blue light. White spot lesions look darker than sound enamel when the fluoresced tooth structure is examined via a particular gelatin filter. Similarly, when a light source is linked via cable to an endoscope, the teeth may be examined without the use of a filter. This is known as white light endoscopy. It has been proven that this approach is effective in detecting early carious lesions. The endoscope is a revolutionary tool used to treat periodontal disease. The endoscope allows one to examine the contents of the periodontal pocket and analyze the root surface of the tooth for disease-causing bacterial accumulations (plaque and calculus) without the need for an incision or surgical therapy. It also aids in the removal of plaque and calculus from the root surface as part of periodontitis treatment. It also allows us to detect other problems (cracks, perforations, and other disease-causing flaws on the surface of the tooth root) that were previously buried behind the gum and required surgery to be detect[57].

Spectroscopy

Alternating current impedance spectroscopy (ACIST)

ACIST sends a low amplitude microamp current into the tooth structure from the sensor tip contact, penetrating the enamel, dentin, and pulp to record changes in mineral density throughout the tooth structure, not only at the surface.

CarieScan PRO® (CarieScan, LLC) is changing the way of detecting caries. It is one of the most dependable equipment in the dentistry business, with 94.8% accuracy in diagnosing caries and healthy tooth structures. The PRO not only identifies when a tooth has to be restored, but it also pinpoints the location of the lesion, allowing restorations (fillings) to be as minimal and cosmetically acceptable as feasible. This device produces minimal false positives, lowering the danger of drilling healthy teeth.

Slično tome, u slučajevima kada je izvor svetlosti povezan kablom sa endoskopom, zubi se mogu pregledati bez upotrebe filtera; ta pojava poznata je kao endoskopija bele svetlosti. Dokazano je da je ovaj pristup efikasan u otkrivanju ranih karijesnih lezija. Endoskop je revolucionarni alat koji se koristi za lečenje parodontalne bolesti. Endoskop omogućava pregled sadržaja parodontalnog džepa i pregled površine korena zuba na akumulacije bakterija koje izazivaju bolesti (plak i kamenac), bez potrebe za rezom ili hirurškom terapijom. Takođe, pomaže u uklanjanju plaka i kamenca sa površine korena u okviru lečenja parodontitisa. Omogućava i uočavanje drugih problema (pukotina, perforacija i drugih nedostataka koji izazivaju bolesti na površini korena zuba) koji su prethodno bili zariveni iza desni i za čije je otkrivanje bila potrebna operacija[57].

Spektroskopija

Spektroskopija otpora naizmenične struje (engl. Alternating current impedance spectroscopy – ACIST)

ACIST šalje struju male amplitude u strukturu zuba od kontakta vrha senzora, prodirući u gleđ, dentin i pulpu kako bi zabeležio promene u mineralnoj gustini u celoj strukturi zuba, a ne samo na površini.

Način otkrivanja karijesa promenio je *CarieScan PRO*® (CarieScan, LLC). To je jedan od najpouzdanijih alata u stomatološkoj praksi, sa 94,8% tačnosti u dijagnostici karijesa i zdravih zubnih struktura. Ne samo da ukazuje na vreme kada zub treba da se restaurira već precizno određuje i lokaciju lezije, omogućavajući pritom da nadoknade (plombe) budu minimalne i estetski prihvatljive onoliko koliko je to moguće. Ovaj uređaj proizvodi minimalne lažne pozitivne rezultate, smanjujući opasnost od bpreparacije zdravih zuba. Smanjuje potrebu za rendgenskim zracima i obezbeđuje merljiv i ponovljiv izlaz kako bi se omogućili kontinuirano praćenje pacijenata i povećanje broja ponovljenih preventivnih tretmana[58].

I zvučni talasi mogu biti korišćeni za otkrivanje karijesa. Ultrazvuk može lako otkriti lezije budući da se vreme putovanja ultrazvučnih impulsa razlikuje u zvučnim i demineralizovanim tkivima gleđi[59,60]. Ova metoda smatra se obećavajućom u otkrivanju ranih lezija gleđi pošto bele mrlje ograničene na gleđ ne proizvode uočljive ili slabe reakcije. S druge strane, dublje lezije proizvode znatno veće amplitude[61].

It reduces the need for X-rays and provides quantifiable and repeatable output to allow for ongoing patient monitoring and an increase in repeat preventive treatments[58].

Sound waves can be used for the detection of caries. Ultrasound can detect lesions easily because the travel time of ultrasonic pulses differs in sound and demineralized enamel tissues[59,60]. This method is considered promising in detecting early enamel lesions because the white spot lesions confined to enamel produce no detectable or weak echoes whereas deeper lesions produce substantially higher amplitudes[61].

Cone Beam Computed Tomography (CBCT)

Cone beam computed tomography (CBCT) systems are a type of computed tomography (CT) technology. Dental experts employ CBCT devices that circle around the patient, collecting data with a cone-shaped X-ray beam. These data are utilized to create a three-dimensional (3D) imaging of the patient's dental (teeth), oral and maxillofacial area (mouth, jaw, and neck), and ears, nose, and throat (ENT). Since the early 2000s, dental CBCT systems have been sold in the United States and are increasingly being used by radiologists and dental professionals for a variety of clinical applications such as dental implant planning, visualization of abnormal teeth, evaluation of the jaws and face, cleft palate assessment, diagnosis of dental caries (cavities), endodontic (root canal) diagnosis, and diagnosis of dental trauma[62–64].

Optic Coherence Tomography

This technique uses a high penetration near-infrared light at a wavelength of 780−1550 nm. No potential biological side effects have been reported on this system so far. Optic coherence tomography (OCT) generates high-resolution cross-sectional images of the oral structures. OCT is found to be more sensitive in the detection of recurrent caries and evaluation of the marginal adaptation of the restorations compared to other tools. Like ultrasonics, OCT uses near-infrared emissions to determine not only the presence of the caries lesions but also measure their depth. Another important advantage of this technique is that the patient is not exposed to X-rays[65].

Cone Beam kompjuterizovana tomografija (engl. Cone Beam computed tomography – CBCT)

Sistemi Cone Beam kompjuterizovane tomografije (engl. Cone Beam computed tomography – CBCT) predstavljaju vrstu tehnologije kompjuterske tomografije (CT). Stomatološki stručnjaci koriste CBCT uređaje koji kruže oko pacijenta i prikupljaju podatke pomoću rendgenskog zraka u obliku konusa. Ovi podaci potom se koriste za kreiranje trodimenzionalne (3D) slike pacijentovog zuba (pacijentovih zubi), oralne i maksilofacijalne oblasti (usta, vilica i vrat) i ušiju, nosa i grla (ENT). Od ranih dvehiljaditih godina, stomatološki CBCT sistemi prodaju se u Sjedinjenim Američkim Državama. Sve ih više koriste radiolozi i stomatolozi u različite kliničke svrhe, među kojima su i planiranje zubnih implantata, vizuelizacija abnormalnih zuba, procena vilica i lica, rascepa procena nepca, dijagnoza zubnog karijesa, endodontska dijagnoza (dijagnoza kanala korena) i dijagnoza stomatološke traume[62-64].

Optička koherentna tomografija

Ova tehnika koristi blisku infracrvenu svetlost visoke prodornosti na talasnoj dužini od 780 nm do 1550 nm. Dosad nisu prijavljeni potencijalni biološki neželjeni efekti na ovaj sistem. Optička koherentna tomografija (engl. Optical Coherence Tomography – OCT) generiše slike poprečnog preseka oralnih struktura visoke rezolucije. Utvrđeno je da je OCT osetljiviji u otkrivanju rekurentnog karijesa i proceni marginalne adaptacije restauracija od drugih alata. Poput ultrazvuka, OCT koristi bliske infracrvene emisije ne samo da bi odredio prisustvo karijesnih lezija već i da bi izmerio njihovu dubinu. Još jedna važna prednost ove tehnike ogleda se u tome što pacijent nije izložen rendgenskim zracima[65].

Terahertz Imaging (THz)

Stomatologija je takođe važan deo THz biomedicine. Karijesno tkivo često ima veće slabljenje transmisije THz od zdrave gleđi i možda neće apsorbovati THz vibracije pre nego da ih disperguju. Štaviše, THz indeks prelamanja gleđi veći je od indeksa dentina. Na osnovu ovih promena navedeno je da transmisija ili refleksija mogu razlikovati karijesnu gleđ od zdrave gleđi. THz impulsi upotrebljavaju se za pravilno i pouzdano otkrivanje debljine gleđi i za skeniranje trodimenzionalne strukture zuba. Pokazalo se i

Terahertz Imaging

Dentistry is also an important part of THz biomedicine. Carious tissue often has a higher THz transmission attenuation than healthy enamel and may not absorb THz vibrations rather than disperse them. Furthermore, the THz refractive index of enamel is greater than that of dentin. Based on these changes, it has been suggested that transmission or reflection imaging may discriminate between carious and healthy enamel. THz pulses were used to properly and reliably detect the enamel thickness and scan the three-dimensional structure of the tooth. THz pulse imaging was also shown to be capable of measuring the depth of artificial acid gel demineralization across a limited range. As a result, THz pulses have the potential to be utilized to detect the depth of a lesion. There is also a small optical fibre-coupled THz endoscope system for oral examination. Although THz technology has been explored in dentistry more extensively than in other medical applications, a more complete and systematic study on the mechanism of THz wave-tooth interaction is necessary[66].

Multiphoton Imaging

A carious lesion in the dentin is a dynamic process that involves demineralization and collagen denaturation. Collagen type I is the most abundant protein in dentin and its optical characteristics have been studied. Multiphoton microscopy (MPM) is a nonlinear imaging method that uses collagen two-photon excitation fluorescence (2PEF) and its second-harmonic generation (SHG) to expose the caries process. Multiphoton tomography (MPT) allows for an optical biopsy depth of up to 200 m with subcellular resolution, allowing for the visualization of cellular and extracellular features. Additional information regarding the microenvironment, energy status, and cellular metabolism may be gained when combined with fluorescent lifetime imaging. With a 700-nanometer excitation wavelength and a 1.3 numerical aperture objective, for example, the observed lateral resolution is roughly 0.2 micrometres, with a matching axial resolution of 0.6 micrometres[67].

da snimanje THz impulsa ima mogućnost da izmeri dubinu demineralizacije veštačkog kiselog gela u ograničenom opsegu, što znači da THz impulsi mogu da se koriste za otkrivanje dubine lezije. Postoji i mali THz endoskopski sistem spregnutih optičkih vlaknana za pregled usne duplje. Iako je primena THz tehnologije bolje istražena u stomatologiji nego u drugim granama medicine, neophodna je potpunija i sistematičnija studija o mehanizmu interakcije između THz talasa i zuba[66].

Multiphoton Imaging

Karijesna lezija u dentinu dinamičan je proces koji uključuje demineralizaciju i denaturaciju kolagena. Kolagen tipa I najzastupljeniji je protein u dentinu. Proučavale su se njegove optičke karakteristike. Multifotonska mikroskopija (engl. *multiphoton microscopy* – MFM) nelinearna je metoda snimanja koja koristi dvofotonsku ekscitaciju fluorescencije (engl. *two-photon excitation fluorescence* – 2PEF) kolagena i njegovu drugu harmoničnu generaciju (DHG) da otkrije proces karijesa. Multifotonska tomografija (engl. *multiphoton tomography* – MFT) omogućava dubinu optičke biopsije do 200 m, sa subcelularnom rezolucijom, dopuštajući tako vizuelizaciju ćelijskih i ekstracelularnih karakteristika. Dodatne informacije u vezi sa mikrookruženjem, energetskim statusom i ćelijskim metabolizmom mogu se dobiti kada se kombinuju sa fluorescentnim snimanjem tokom života. Sa talasnom dužinom pbudjivanje od 700 nm i objektivom sa numeričkim otvorom od 1,3, na primer, posmatrana lateralna rezolucija iznosi otprilike 0,2 mikrometra, sa odgovarajućom aksijalnom rezolucijom od 0,6 mikrometara[67]

Kompjuterska tomografija sa podešenim otvorom blende (engl. Tuned Aperture Computed Tomography – TACT)

Webber et al. razvili su kompjuterizovanu tomografiju sa podešenom blendom (engl. *Tuned Aperture Computed Tomography – TACT*), veoma jednostavan i brz pristup za rekonstrukciju tomografskih slika[68]. Zasnovan je na konceptima tomosinteze i teorije optičkog otvora. TACT počinje sa 2D periapikalnim radiografijama snimljenim iz različitih uglova projekcije, a zatim generiše uzdužne tomografske rezove (TACT-S) koji bivaju poređani u *Z*-osi oblasti od interesa.

Tuned Aperture Computed Tomo-graphy (TACT)

Webber and colleagues developed tuned aperture computed tomography (TACT), a very simple, quicker approach for reconstructing tomographic images[68]. It is based on the tomosynthesis and optical aperture theory concepts. TACT starts with 2-D periapical radiographs recorded from various projection angles and then generates longitudinal tomographic slices (TACT-S) that line up in the Z-axis of the area of interest. It generates real 3-D data from an arbitrary number of 2-D projections. TACT has proven to be a promising and successful alternative to other traditional modalities in a variety of therapeutic settings. TACT's total radiation exposure is no more than 1 to 2 times that of a standard periapical X-ray film. The resolution is said to be comparable to that of 2-D radiography. TACT does not have the artifacts associated with CT, such as starburst patterns found with metallic restorations[69].

This overview highlighted a huge variety of current equipment that is either now used or can be utilized in dental diagnostics. Some of these devices are rather pricey and take up a lot of room. Some are quite inexpensive and can be used in routine dental diagnostics. Technology evolves so quickly that it is impossible to stay up. As a result, possibly the best answer for each pedodontist or pedodontics clinic is to select the equipment with the greatest cost benefit.

Generiše stvarne 3D podatke iz proizvoljnog broja 2D projekcija. TACT se pokazao kao obećavajuća i uspešna alternativa drugim tradicionalnim modalitetima u različitim terapijskim okruženjima. Ukupna izloženost zračenju TACT-a nije više od jednog do dva puta veća od standardnog periapikalnog rendgenskog filma. Rezolucija se može uporediti sa rezolucijom 2D radiografije. TACT nema artefakte povezane sa CT-om, kao što su obrasci zvezdanog praska koji se nalaze kod metalnih restauracija[69].

U ovom preglednom radu predstavljena je oprema koja se trenutno koristi u stomatološkoj dijagnostici, kao i ona koja u te svrhe može biti korišćena u budućnosti. Pojedini od navedenih uređaja prilično su skupi i zauzimaju mnogo prostora. Ima i onih koji su jeftini i koji mogu biti korišćeni u rutinskoj stomatološkoj dijagnostici. Razvoj tehnologije je toliko brz da je skoro nemoguće ostati u toku. Shodno tome, možda je za svakog pedodonta ili pedodontsku kliniku najbolje rešenje da odabere opremu koja se najviše isplati.

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REGENERATIVNA PARODONTALNA TERAPIJA – II deo

REGENERATIVE PERIODONTAL THERAPY: PART II

Milica S. Petrović[1], Ljiljana G. Kesić[1,2], Radmila R. Obradović[1,2], Ana N. Pejčić[1,2], Marija D. Bojović[1,2], Simona M. Stojanović[2,3], Branislava B. Stojković[2,4], Ivana V. Stanković[1], Nenad M. Stošić[2,5], Milan S. Spasić[2,3]

[1]UNIVERZITET U NIŠU, MEDICINSKI FAKULTET, KATEDRA ORALNA MEDICINA I PARODONTOLOGIJA, NIŠ, SRBIJA
[2]KLINIKA ZA DENTALNU MEDICINU, NIŠ, SRBIJA
[3]UNIVERZITET U NIŠU, MEDICINSKI FAKULTET, KATEDRA ORALNA HIRURGIJA, NIŠ, SRBIJA
[4]UNIVERZITET U NIŠU, MEDICINSKI FAKULTET, KATEDRA PREVENTIVNA I DEČJA STOMATOLOGIJA, NIŠ, SRBIJA
[5]UNIVERZITET U NIŠU, MEDICINSKI FAKULTET, KATEDRA BOLESTI ZUBA I ENDODONCIJA, NIŠ, SRBIJA

[1]UNIVERSITY OF NIŠ, FACULTY OF MEDICINE, DEPARTMENT OF ORAL MEDICINE AND PERIODONTOLOGY, NIŠ, SERBIA
[2]CLINIC OF DENTAL MEDICINE, NIŠ, SERBIA
[3]UNIVERSITY OF NIŠ, FACULTY OF MEDICINE, DEPARTMENT OF ORAL SURGERY, NIŠ, SERBIA
[4]UNIVERSITY OF NIŠ, FACULTY OF MEDICINE, DEPARTMENT OF PREVENTIVE AND PAEDIATRIC DENTISTRY, NIŠ, SERBIA
[5] UNIVERSITY OF NIŠ, DEPARTMENT OF RESTORATIVE DENTISTRY AND ENDODONTICS, NIŠ, SERBIA

Sažetak

Uvod: *Parodontalna oboljenja dovode do morfološke i funkcionalne dezintegracije potpornog aparata zuba, a osnova koncepta hiruške parodontalne terapije jeste eliminacija parodontalnih džepova, sa koštanim remodeliranjem i kreiranjem fiziološke arhitekture na apikalnijem nivou, čime se postižu bolji uslovi kontrole dentalnog plaka. U parodontalnom ligamentu postoje progenitorske ćelije koje služe za obnavljanje izgubljenog epitelnog pripoja. Vođena tkivna regeneracija (engl. guided tissue regeneration – GTR) jeste zahvat koji omogućuje sanaciju parodontalnog defekta ćelijama koje mogu stvoriti novi vezivni pripojni epitel i povećati nivo alveolarne kosti, a njen cilj je da recesija gingive bude što je moguće manja.*
Cilj: *Cilj ovog rada bio je predstaviti savremene pristupe terapiji obolelog parodoncijuma koji su usmereni na regeneraciju i kompletnu rekonstrukciju parodontalnih tkiva.*
Zaključak: *Razlika u pogledu ishoda regenerativne parodontalne terapije odnosi se na stepen saradnje pacijenta i terapeuta, nivo održavanja oralne higijene, odabir defekata, kao i na način hiruškog rada. Visok nivo kontrole dentalnog plaka i eliminacija patogene mikroflore, kao i intenzivna antimikrobna parodontalna terapija, poboljšavaju ishod parodontalne regenerativne terapije.*

Ključne reči: *parodontalna hirurgija, vođena regeneracija tkiva*

Corresponding author:
Assistant Professor Milica S. Petrović, DMD, PhD,
Faculty of Medicine, University of Niš
52 Dr. Zorana Djindjića Blvd., 18000 Niš Serbia,
E-mail: petrovicsmilica@gmail.com

Abstract

Introduction: *The periodontal diseases lead to the morphological and functional disintegration of the tooth-supporting apparatus, and a basic concept of surgical periodontal therapy is the elimination of periodontal pockets with the bone remodelling and creating the physiological architecture at a more apical level, thereby achieving better conditions for dental plaque control. The progenitor cell population in the periodontal ligament is served for the reconstruction of lost epithelial attachment. Guided Tissue Regeneration (GTR) is a procedure that allows for the repair of a periodontal defect by cells capable of creating new connective tissue attachment and alveolar bone, and the aim is a minimization of postoperative gingival recession. The objectives of GTR are the creation of a new epithelial attachment, an increase in the bone level, and the minimization of postoperative gingival recession.*
Aim: *Presentation of modern approaches, materials, prognostic factors as well as complications of periodontal therapy that are focused on attachment regeneration and complete reconstruction of periodontal tissue.*
Conclusion: *The difference in terms of outcomes of regenerative periodontal therapy relates to the degree of patient's cooperation with the therapist, the level of oral hygiene, the selection of an appropriate bone defect, as well as the methods of surgery. The high level of dental plaque control, elimination of pathogenic microflora and intensive antimicrobial periodontal therapy improve the outcome of periodontal regenerative therapy.*

Key words: *periodontal surgery, guided tissue regeneration*

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Vođena regeneracija tkiva (engl. guided tissue regeneration – GTR)

Parodontalna oboljenja dovode do morfološke i funkcionalne dezintegracije potpornog aparata zuba, a osnova koncepta hiruške parodontalne terapije jeste eliminacija parodontalnih džepova, sa koštanim remodeliranjem i kreiranjem fiziološke arhitekture na apikalnijem nivou, čime se postižu bolji uslovi kontrole dentalnog plaka[1]. Prvi zapisi o vođenoj regeneraciji tkiva kao kliničkoj parodontalnoj hirurgiji nastali su pre više od 25 godina[2,3]. Ciljevi vođene regeneracije tkiva jesu stvaranje novog epitelnog pripoja, povećanje nivoa kosti i najmanja moguća postoperativna gingivalna recesija[3,4]. Sve vrste parodontalnih bolesti uzrokovane su mikroorganizmima dentalnog plaka, s tim što dodatni faktori poput traume, starenja, genetike, sistemskih bolesti i sl. doprinose još većoj destrukciji parodonta.

Glavni cilj u terapiji parodontalnih oboljenja jeste obnova parodonta i regeneracija parodontalnih tkiva. Danas plan terapije reparacije parodonta podrazumeva anti-inflamatorne mere (obrada i poliranje korena), vođenu regeneraciju tkiva (sa koštanim transplantatom ili bez njega) i/ili upotrebu faktora rasta; nijedan od njih neće sam po sebi u potpunosti obnoviti strukturu parodonta[5].

Vođena tkivna regeneracija (engl. *guided tissue regeneration* – GTR) jeste zahvat koji omogućuje sanaciju parodontalnog defekta ćelijama koje mogu stvoriti novi vezivni pripojni epitel i alveolarnu kost. Istraživanjima je utvrđeno da se prethodnici ćelija za stvaranje novog vezivnog pripojnog epitela nalaze u periodoncijumu[6,7,8].

Shodno tome, smatra se da je moguće dobiti novi vezivni pripojni epitel ako takve ćelije nasele površinu korena u toku zarastanja. To se može postići izolacijom ćelija epitelnog i vezivnog tkiva gingive iz područja zarastanja primenom fizičke membrane, koja će omogućiti ćelijama periodontalnog ligamenta da ponovo nasele površinu korena[9].

Izolacija brzorastućeg epitelnog i vezivnog tkiva iz parodontalne rane omogućiće spororastućem tkivu da zauzme prostor oko zuba za 6–8 nedelja. Osteoblasti, cementoblasti i ćelije periodoncijuma tada imaju mogućnost regeneracije novog pripojnog epitela na prethodno izmenjenoj površini korena. Dodatno objašnjenje principa delovanja membrane jeste osiguravanje dovoljnog prostora za optimalnu stabilnost rane, koji je neophodan za samu regeneraciju parodontalnih tkiva[10].

Guided tissue regeneration—GTR

The periodontal diseases lead to the morphological and functional disintegration of the tooth-supporting apparatus, and a basic concept of surgical periodontal therapy is the elimination of periodontal pockets with the bone remodelling and creating the physiological architecture at a more apical level, thereby achieving better conditions for dental plaque control[1]. The first documents on guided tissue regeneration (GTR), as clinical periodontal surgery, were created more than 25 years ago[2,3]. The objectives of GTR are the creation of a new epithelial attachment, an increase in the bone level, and the minimization of postoperative gingival recession[3,4]. All types of periodontal diseases are caused by microorganisms of dental plaque, although additional factors such as trauma, ageing, genetics, systemic diseases etc., contribute to even greater destruction of the periodontium.

The main goal in the therapy of periodontal diseases is the restoration of the periodontium and the regeneration of periodontal tissues. Today, the treatment plan for periodontal repair includes anti-inflammatory measures (scaling and root planning), guided tissue regeneration (with or without a bone graft), and/or the use of growth factors, none of them will completely restore the structure of the periodontium on their own[5].

GTR is a procedure that allows for the repair of a periodontal defect by cells capable of creating new connective tissue attachment and alveolar bone. Researchers have determined that precursors of cells for the creation of new connective epithelial attachment are located in the periodontal tissues[6,7,8].

Accordingly, it is considered possible to obtain a new connective tissue epithelial attachment if such cells colonize the root surface during healing. This can be achieved by isolating epithelial and connective tissue cells of the gingiva from the healing area by using a physical barrier membrane, which will allow cells of the periodontal ligament to re-colonize the root surface[9].

The isolation of a fast-growing epithelial and connective tissue from the periodontal wound over 6−8 weeks will allow the slower-growing tissue to occupy the space around the tooth. Osteoblasts, cementoblasts, and periodontal cells then have the opportunity to regenerate new epithelial attachment on the previously altered root surface.

Slični principi GTR-a primenjeni su kod defekta alveolarne kosti pri regeneraciji. Proces regeneracije kosti isti je kao nakon ekstrakcije zuba – stvaranje krvnog koaguluma inicira stvaranje nove kosti i revaskularizaciju tkiva s periferije defekta. Tako stvorena kost postupno se zamenjuje košću lamelarne strukture, a onda sledi sazrevanje i remodeliranje sekundarnih osteona. Ovakvim pristupom u regeneraciji specifičnog tkiva nije ostvarena veza između tkiva i zuba. Reč je o vođenoj regeneraciji kosti (engl. *guided bone regeneration* – GBR). GBR tehnika unapređena je u GTR, koji podrazumeva kompleksniju regeneraciju sa više specifičnih tkiva.

Mnogo pre nego što je uveden koncept GTR, uočeno je da će se kavitet s pristupom osteoblasta i krvnim sadržajem ispuniti novom kosti ako je izolovan od okolnog mekog tkiva, kao i da će se u slučaju izostanka izolacije ispuniti fibroznim tkivom[11].

Indikacije za vođenu regeneraciju tkiva su intrakoštani trozidni i dvozidni koštani defekti, furkacije korena II stepena i lokalizovane gingivalne recesije. Jednozidni intrakoštani defekti, furkacije II stepena u gornjoj vilici i furkacije III stepena u donjoj vilici slabo reaguju na vođenu regeneraciju tkiva. Pre vođene regeneracije tkiva treba sprovesti odgovarajuću kauzalnu parodontalnu terapiju.

GTR nije postupak za lečenje parodontopatije, već metoda regenerisanja defekata koji su se razvili kao posledica parodontalnog oboljenja. Samim tim, uvek treba sprovesti odgovarajuću kauzalnu terapiju parodontopatije pre nego se započne sa primenom GTR-a[9]. Naime, brojne kliničke studije pokazale su da je GTR uspešan tretman u parodontalnoj rekonstruktivnoj hirurgiji, te je usvojen kao jedan od češće korišćenih zahvata u parodontalnoj praksi, samostalno ili zajedno sa drugim metodama lečenja[5,12,13,14].

Izvođenje postupka

Zahvat počinje sulkusnim ili rubnim incizijama, a potom se izvode vertikalni oslobađajući rezovi i odiže se režanj pune debljine. Na režnju se ostavlja sveže vezivno tkivo i time se uklanja sav epitel džepa. Granulaciono tkivo najpre se uklanja, a zatim se struže (obrađuje) i polira koren. Membrana se bira po obliku i osobinama, a onda se prilagođava tako da prekrije defekt. Membrana se pruža preko kosti barem 3 mm od ruba defekta. Potrebno je osigurati dobru povezanost sa alveolarnom kosti i tako izbeći preklapanje ili nabiranje membrane. Rubovi režnja pomeraju se koronarno i ušivaju tako da rub membrane bude 2 mm ispod ruba režnja.

An additional explanation of the principle of membrane's action is to ensure enough space for optimal wound stability, necessary for the regeneration of periodontal tissues itself[10].

Similar principles of GTR are applied to the regeneration of alveolar bone defects. The process of bone regeneration is similar to the process that follows tooth extraction—the formation of a blood clot initiates the creation of new bone and revascularization of tissue from the periphery of the defect. The created bone is gradually replaced with the lamellar bone structure, followed by maturation and remodelling of the secondary osteons. With this approach in the regeneration of specific tissue, a connection between tissue and tooth is not completed. This procedure is referred to as Guided Bone Regeneration (GBR). The GBR technique has been refined into GTR, which is a more complex procedure of regeneration involving more specific tissues. Long before the introduction of the GTR concept, it was observed that a cavity with access to osteoblasts and blood content would fill with new bone if it were isolated from the surrounding soft tissue, unlike in the same situation without isolation, when it would be filled with fibrous tissue[11].

Indications for GTR include intra-bony defects that are three-walled and two-walled, grade II furcations, and localized gingival recessions. Single-walled intra-bony defects, grade II furcations in the upper jaw, and grade III furcations in the lower jaw respond poorly to GTR. Before proceeding with GTR, appropriate causal periodontal therapy should be performed.

GTR is not a procedure for the treatment of periodontitis but a method for regenerating defects caused by periodontal disease. Therefore, appropriate periodontal causal treatment should always be carried out before the beginning of the GTR[9]. Thus, numerous clinical studies have shown that GTR is a successful treatment in periodontal reconstructive surgery, adopted as one of the more frequently used procedures in periodontal practice, either alone or in conjunction with other treatment methods[5,12,13,14].

The performance of a procedure

The procedure begins with sulcular or marginal incisions. Then, vertical releasing incisions are made, and a full-thickness flap is elevated. Fresh connective tissue has to be left on the flap, and all the pocket epithelium removed.

Treba motisvisati pacijenta da nakon operacije pravilno održava oralnu higijenu kako bi se smanjio rizik od infekcije i eventualne traume. Operisano područje se prve dve nedelje ne četka, a kasnije se nežno četka mekom četkicom i ispire 0,12% – 0,2% hlorheksidinom dva ili tri puta dnevno.

Antibiotici (tetraciklini i amoksicilin) se ne propisuju sistematski, budući da nije dokazana nikakva prednost njihove upotrebe kada je reč o zarastanju i konačnom rezultatu. Neresorptivna membrana uklanja se nakon od 3 nedelje do 6 nedelja. Ako se upotrebljavaju bioresorptivne membrane, period kontrole eventualne infekcije u usnoj šupljini produžava se na 6–8 nedelja. Preporučuje se nastavak parodontalnog tretmana uz izbegavanje sondiranja, obrade i poliranja operisanog područja u periodu od šest meseci do godinu dana[3,9].

Membrane za parodontalnu regeneraciju

Glavni cilj membrane u GTR-u jeste odvajanje gingivalnog epitela i vezivnog tkiva od površine korena. Prostor koji se dobija membranom dopušta ćelijama periodoncijuma da nasele površinu korena zuba. Membrana za regeneraciju tkiva mora biti biokompatibilna, imati osobinu ekskluzije ćelija, čuvati prostor, izdržati mastikatorne sile, integrisati se sa tkivom i biti jednostavna za upotrebu. U kriterijume koje bi trebalo da zadovoljava idealna membrane spadaju biokompatibilnost, održavanje prostora, integracija tkiva, sposobnost stvaranja i održavanja prostora uz koren i resorptivnost[3]. Membrane se dele na neresorptivne i resorptivne[15].

Neresorptivne membrane

S obzirom na to da zadržavaju građu i oblik u tkivima, neresorptivne membrane uklanjaju se hirurškim zahvatom. Prva generacija membrana GoreTex® e-PTFE sastavljena je od okluzivne membrane i otvorenog mikrostrukturisanog okovratnika koji se nalazi koronarno. Okovratnik pospešuje urastanje vezivnog tkiva, sprečava apikalnu migraciju epitela i osigurava stabilnost rane. Okluzivna membrana održava prostor za regeneraciju i prepreka je prema mukogingivalnom režnju.

Ugradnjom titana između dva sloja e-PTFE-a povećava se mehanička čvrstoća i bolje se čuva prostor. Nakon postavljanja, može doći do kolonizacije bakterijama i upale okolnog tkiva[16].

Granulation tissue is removed, then the scaling and root planning is performed. The membrane is selected based on the shape and characteristics, and then it is adjusted to cover the defect. The membrane extends over the bone at least 3 mm from the edge of the defect. It is necessary to ensure a good connection with the alveolar bone and to avoid overlapping or bunching of the membrane. The edges of the flap are moved coronal and sutured so that the edge of the membrane is 2 mm below the edge of the flap.

After periodontal surgery, the patient should be motivated to maintain proper oral hygiene, to reduce the risk of infection and potential trauma. The operated area should not be brushed for the first two weeks, and later has to be brushed gently with a soft brush and rinsed with 0.12−0.2% chlorhexidine two to three times a day.

Antibiotics (tetracyclines and amoxicillin) are not prescribed systemically, as no advantage has been proven in healing or the outcome. Non-resorbable membranes have to be removed after 3−6 weeks. With the use of bioresorbable membranes, the period for controlling possible infection in the oral cavity has been extended to 6–8 weeks. Continuation of periodontal treatment with avoidance of probing, scaling and root planing of the operated area for 6 months to a year is recommended[3,9].

Membranes for periodontal regeneration

The primary goal of the barrier membrane in GTR is to separate the gingival epithelium and connective tissue from the root surface. The space created by the membrane allows periodontal cells to colonize the tooth root surface. A membrane for tissue regeneration must be biocompatible, have cell exclusion properties, maintain space, withstand masticatory forces, integrate with tissue, and has to be easy to use. The ideal membrane should meet the following criteria: biocompatibility, space maintenance, tissue integration, ability to create and maintain space near the root, and resorbability[3]. Membranes are divided into non-resorbable and resorbable[15].

Non-resorbable barrier membranes

These membranes retain structure and shape in tissues, and they could be removed by surgical procedure. GoreTek® e-PTFE (expanded polytetra-fluoroethylene) membrane is the first generation of a barrier membrane,

Resorptivne membrane

Uvedene su u primenu GTR-a kao druga generacija membrana, s ciljem da se izbegne druga operacija uklanjanja. Upotrebom resorptivne membrane smanjuje se mogućnost posthirurških komplikacija. Građene su od prirodnih i sintetičkih materijala[16,17].

Resorptivne membrane od prirodnih materijala

Bio-Gide® membrana napravljena je od kolagena tipa I i III, uzetog iz svinjskog dermisa. Kolagen se proizvodi u nekoliko faza u kojima se dobija kolageni dvosloj – on se tretira bazama da bi se eliminisala kontaminacija bakterijama ili virusima. Terminalne peptidne regije od kojih zavisi antigenost odvajaju se i uklanjaju se ostaci lipida i proteina. Kontrolišu se bio-kompatibilnost i sterilnost. Konačni proizvod sastoji se od čistih kolagenih vlakana, bez ostataka i hemijskih supstanci.

Bio-Mend® membrane napravljene su od kolagena tipa I, uzetog iz goveđe tetive. Kolagen razgrađuju makrofagi i polimorfo-nuklearni neutrofili. Enzim kolagenaza deli molekul kolagena na delove koji se denaturišu i prelaze u želatin. Želatin se dalje preko gelatinaza i proteinaza razgrađuje do amino-kiselina. Bio-Gide® membrana razgrađuje se za 24 nedelje, a Bio-Mend® membrana za 6–8 nedelja.

Resorptivne membrane napravljene od sintetičkih materijala

Sintetički materijali za resorptivne membrane derivati su organskih alifatskih termoplastičnih polimera. Najviše se koriste poli-α-hidroksilne kiseline, u koje se ubrajaju polilaktična i poliglikolna kiselina. Njihovu prednost predstavlja razgradnja hidrolizom do vode i ugljen-dioksida.

Guidor® je dvoslojna resorptivna membrana. Spoljašnji sloj membrane ima četvorougaone otvore koji potiču od urastanja tkiva, što znači da se postoperativna recesija gingive smanjuje. Unutrašnji sloj ima stopere i unutrašnje otvore koji čuvaju prostor između membrane i korena.

Resolute® ima okluzivnu membranu koja sprečava urastanje tkiva i porozni deo koji poboljšava integraciju tkiva. Atrisorb® je jedina membrana koja se priprema intraoperativno. Polilaktični polimer je u tečnom obliku i otopljen u N-metil-2-pirolidonu. Membrana nastaje tek nakon 4–6 minuta, kada se doda fiziološki rastvor. Seče se prema želji terapeuta.

composed of an occlusive membrane and an open micro-structured collar located coronary. The collar promotes the ingrowth of connective tissue, prevents apical migration of the epithelium, and ensures wound stability. The occlusive membrane maintains space for regeneration and acts as a barrier to the mucogingival junction.

By embedding titanium between 2 layers of e-PTFE, mechanical strength is increased and space is better preserved. After placement, colonisation by bacteria and inflammation of the surrounding tissue can occur[16].

Resorbable barrier membranes

GTR membranes have been introduced as the second generation of membranes to avoid the multiple operative procedures. The use of resorbable membranes reduces the possibility of post-surgical complications. They are made of natural and synthetic materials[16,17].

Resorbable membranes, made from natural materials

The Bio-Gide® membrane are made from type I and III collagen, taken from the pig dermis. The collagen is produced in several stages where a collagen bilayer is obtained, which is treated with bases to eliminate bacterial or viral contamination. Terminal peptide regions, which depend on antigenicity, are separated, and remnants of lipids and proteins are removed. Biocompatibility and sterility are controlled. The final product consists of pure collagen fibres without residues and chemical substances.

The Bio-Mend® membranes are made from type I collagen, taken from bovine tendon. The collagen is degraded by macrophages and polymorphonuclear neutrophils. The enzyme collagenase breaks the collagen molecule into parts that denature and turn into gelatin. Gelatin is further degraded into amino acids by gelatinases and proteinases. The Bio-Gide® membrane degrades over 24 weeks, while Bio-Mend® degrades in 6−8 weeks.

Resorbable barrier membranes made from synthetic materials

Synthetic materials for resorbable membranes are derivatives of organic aliphatic thermoplastic polymers. Poly-α-hydroxy acids are most commonly used, including polylactic and polyglycolic acids.

Njena debljina iznosi od 600 μm do 750 μm. Postavlja se u defekt laganim pritiskom i tako se pripaja[15].

Nema dokaza da između bioresorptivne i neresorptivne (e-PTFE) membrane postoji razlika u kvalitetu stvaranja kliničkog pripojnog epitela i smanjenja dubine sondiranja[10]. Prema novijim istraživanjima, GTR se u terapiji intrakoštanih i furkacijskih defekata pokazala uspešnijom od konvencionalne operacije otvorenog režnja (engl. *open flap debridement* – OFD)[18,19,20]. Stvara se klinički epitelni pripoj i smanjuje dubina sondiranja kod defekata kosti i otvorenih furkacija.

Komplikacije

U vođenoj regeneraciji tkiva komplikacije su česte i povezuju se sa pogoršanjem parodontalnog zdravlja i izostankom kliničkog uspeha. Izloženost membrane navodi se kao glavna komplikacija u 70% – 80% slučajeva[21,22]. Učestalost izloženosti membrane smanjena je primenom modifikovanih tehnika pristupnog režnja (modifikovana tehnika očuvanja papile, očuvanje aproksimalnog tkiva i pojednostavljena tehnika očuvanja papile) koje štede interdentalno tkivo. Veoma je važna kontrola izloženosti membrane pošto je kontaminiranost bakterijama dokazana. Kontaminacija resorptivnih i neresorptivnih membrana povezana je sa smanjenjem dobijenog epitelnog pripoja kod intraosealnih defekata.

Kao druge postoperativne komplikacije mogu se izdvojiti edem, eritem, supuracija, klizanje ili perforacija režnja i postoperativna bol. Postoperativna bol kontroliše se analgeticima. Lokalna kontaminacija bakterijama kontroliše se upotrebom hlorheksidina u obliku rastvora za ispiranje ili gelova, kao i korišćenjem mekih četkica za zube. Perforacija režnja i ozbiljna izloženost membrane u nekim slučajevima mogu rezultirati odstranjivanjem membrane[23].

Prognostički faktori u rege-nerativnoj parodontalnoj terapiji

Primenom različitih pristupa identifikovan je velik broj prognostičkih faktora koji mogu biti povezani sa pacijentom ili sa defektom koji se obrađuje.

Their advantage is decomposition by hydrolysis into water and carbon dioxide.

Guidor® is a dual-layer resorbable membrane. The outer layer of the membrane has quadrangular openings that promote tissue ingrowth, meaning that postoperative recession of the gingiva is rarely reduced. The inner layer has stoppers and internal openings that preserve the space between the membrane and the root.

Resolute® has an occlusive membrane that prevents tissue ingrowth and a porous part that enhances tissue integration. Atrisorb® is the only membrane that is prepared intraoperatively. The polylactic polymer is in liquid form and dissolved in N-methyl-2-pyrrolidone. The membrane is formed after 4−6 minutes, when a physiological solution is added. The therapist makes cutting decisions. Membrane thickness is 600−750 μm. It is placed in the defect with gentle pressure and thus adhered[15].

There is no evidence that there is a difference between bioresorbable and non-resorbable (e-PTFE) membranes in the quality of clinical attachment of epithelium formation and reduction of pocket probing depth10. According to more recent research, GTR has been proven to be more successful in the therapy of intrabony and furcation defects than conventional open flap debridement (OFD) surgery[18,19,20]. Clinical epithelial attachment is formed and pocket probing depth reduced in the bone and open furcation defects.

Complications

Complications in GTR are common and associated with the deterioration of periodontal health and the absence of clinical success. Membrane exposure is cited as the main complication in 70–80% of cases[21,22]. The frequency of membrane exposure is reduced by using modified flap access techniques (modified papilla preservation technique, preservation of approximal tissue, and simplified papilla preservation technique) that save interdental tissue. Control of membrane exposure is very important, as bacterial contamination has been proven. Contamination of resorbable and non-resorbable membranes is associated with a reduction in the achieved epithelial attachment in the intraosseous defects.

Other postoperative complications include oedema, erythema, suppuration, flap slippage or perforation, and postoperative pain. Postoperative pain is controlled with analgesics.

Faktori povezani sa pacijentom

Regenerativnom terapijom parodontopatije ne leči se parodontopatija, nego se deluje na regeneraciju defekata do kojih je ovo oboljenje dovelo. Najpre treba sprovesti kauzalnu parodontalnu terapiju, a zatim započeti postupak regeneracije. Ako kod pacijenata sa završenim ciklusom kauzalne parodontalne terapije i sa lošom oralnom higijenom prilikom sondiranja dođe do krvarenja i visoke koncentracije specifičnih mikrooragnizama, ishod regenerativne parodontalne terapije biće los[25,26,27].

Nivo održavanja higijene ima veliki uticaj na ishod parodontalne regeneracije. Kod pacijenata sa optimalnom oralnom higijenom primećen je viši nivo kliničkog epitelnog pripoja nego kod pacijenata čija je oralna higijena bila lošija od idealne[25,26,28].

Možemo zaključiti da visok nivo kontrole dentalnog plaka i eliminacija patogene mikroflore, kao i intenzivna antimikrobna parodontalna terapija, poboljšavaju ishod parodontalne regenerativne terapije.

Pušenje

Retrospektivnim istraživanjem potvrđeno je da su ishodi regenerativne terapije znatno lošiji kod pušača nego kod nepušača[25]. Nizom istraživanja pokazano je da konzumacija cigareta utiče na smanjenje nivoa kliničkog epitelnog pripoja[29,30,31]. Iako nema formalnih dokaza, treba preporučiti pacijentima da prestanu sa ovom navikom. Takođe, treba ih obavestiti o mogućnostima slabijeg rezultata terapije, ali i preporučiti im da ne konzumiraju cigarete pre i posle terapijskog zahvata.

Drugi faktori povezani sa pacijentom

Smatra se da i drugi faktori koji se tiču pacijenta, kao što su starost, genetika, sistemska oboljenja ili nivo stresa, mogu biti povezani sa suboptimalnim regenerativnim ishodima. U nedostatku dokaza, može se reći da nema potrebe za bilo kakvim dodatnim postupcima, osim u slučaju da postoje kontraindikacije za hirušku terapiju (npr. nekontrolisani ili nestabilni dijabetes, teške bolesti i sl.).

Local bacterial contamination is controlled by using chlorhexidine in the form of rinsing solutions or gels, as well as soft toothbrushes. Flap perforation and severe membrane exposure in some cases can result in membrane removal[23].

Prognostic factors in regenerative periodontal therapy

Development of the application of different approaches suggests that a large number of prognostic factors have been identified, which may be related to the patient or the treated defect.

Patient-Related Factors

Regenerative therapy for periodontitis cannot treat periodontitis itself, but rather aims to regenerate defects that have occurred during the course of the disease. It is necessary to first perform causal periodontal therapy, and then begin the regeneration process. In patients who completed a cycle of causal periodontal therapy, but have not maintained good oral hygiene, the presence of bleeding upon probing and a high concentration of specific microorganisms will likely result in poor outcome of regenerative periodontal therapy[24,25,26,27].

The level of hygiene maintenance has a significant impact on the outcome of periodontal regeneration. In patients with optimal oral hygiene, a higher level of clinical epithelial attachment may be observed compared to patients with a less than optimal oral hygiene status[25,26,28].

We can conclude that a high level of dental plaque control and elimination of pathogenic microflora, as well as intensive antimicrobial periodontal therapy, improve the outcome of periodontal regenerative therapy.

Smoking

A retrospective study confirmed that smokers exhibited significantly reduced regenerative outcomes when compared to non-smokers[25]. A number of studies have shown that cigarette smoking reduce the levels of clinical epithelial attachment[29,30,31]. Although there is no formal evidence, patients should be advised to stop smoking, they should be informed about the possibility of a poor therapeutic outcome, as well as given advice on smoking cessation before and after the therapeutic procedure.

Faktori povezani sa defektom

Vrste defekata

Trenutno dostupne parodonatalne regenerativne procedure ne pružaju dokaze da se suprakoštani defekti i furkacije III stepena mogu lečiti regenerativnim pristupom. Ova ograničenja odnose se i na interdentalne kratere, tako da infrakoštani defekti i defekti furkacije II klase mogu biti lečeni na ovaj način.

Morfologija defekata

Morfologija defekata ima važnu ulogu u zarastanju rane nakon parodontalnog regenerativnog lečenja infrakoštanih defekata. To se pokazalo u istraživanju u kojem su dubina i širina koštanog defekta uticale na nivo novog kliničkog epitelnog pripoja i dobijanja alveolarne kosti, i to nakon godinu dana. Dublji defekt imao je viši nivo kliničkog epitelnog pripoja. Uvidelo se i sledeće: što je širi defekt, dobijanje epitelnog pripoja i kosti je manje[28,32].

Faktori povezani sa zubom

Endodontski status zuba smatra se potencijalno važnim faktorom u parodontalnom lečenju. Sve je više dokaza o tome da endodontski lečeni zubi drugačije reaguju na parodontalnu terapiju. Kliničko ispitivanje koje je obuhvatilo 208 ispitanika sa jednim intrakoštanim defektom pokazalo je da pravilno sprovedena terapija endodontska terapija ne utiče negativno na dugotrajnu stabilnost rezultata lečenja dubokih intrakoštanih defekata tretiranih membranama[33].

Teška nekontrolisana pokretljivost zuba (klasa II po Mileru ili više) može ugroziti regenerativni terapeutski tretman.

Zaključak

Vođena regeneracija tkiva predstavlja najbolje dokumentovani postupak za regeneraciju parodonta u intrakoštanim defektima i furkacijama II stepena. Razlika u pogledu ishoda regenerativne parodontalne terapije odnosi se na stepen saradnje pacijenta i terapeuta, nivo održavanja oralne higijene, odabir defekata, te način hiruškog rada.

The other patient-related factors

It is believed that other patient-related factors such as age, genetics, systemic diseases, or stress levels can be associated with sub-optimal regenerative outcomes. Despite a lack of evidence, no action is necessary unless there are contraindications for surgical therapy (e.g., uncontrolled or unstable diabetes, severe illnesses, etc.).

Defect-related factors

Types of defects

Currently available periodontal regenerative procedures do not provide evidence that suprabony defects and grade III furcations can be treated with a regenerative approach. These limitations also apply to interdental craters, meaning that infrabony defects and Class II furcation defects can be treated in this way.

Defect Morphology

The morphology of defects plays an important role in the healing of a wound after periodontal regenerative treatment of infrabony defects. A research showed that the depth and width of the bone defect affected the level of new clinical epithelial attachment and gain of alveolar bone after one year. A deeper defect was associated with a higher level of clinical epithelial attachment, while a wider defect was linked to decreased epithelial attachment and bone gain[28,32].

Tooth-related factors

The endodontic status of a tooth is considered a potentially important factor in periodontal treatment. There is increasing evidence that teeth treated endodontically respond differently to periodontal therapy. A clinical trial that included 208 participants with a single intrabony defect showed that properly conducted endodontic therapy did not negatively affect the long-term stability of the treatment results of deep intrabony defects treated with membranes[33].

Severe uncontrolled tooth mobility (Miller Class II or upper) may compromise the regenerative therapeutic treatment.

Conclusion

GTR is the best documented procedure for periodontal regeneration in intraosseous defects and grade II furcations. The difference patient's cooperation with the therapist, the level of his oral hygiene, the selection of an appropriate defect, as well as the methods of surgery.

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Conflicts of Interest statement

The authors declare no conflicts of interest.

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UPOTREBA DELEROVE MASKE ZA LICE U LEČENJU MALOKLUZIJE III KLASE

USAGE OF DELAIRE FACEMASK FOR TREATMENT OF CLASS III MALOCCLUSION

Olivera Terzieva Petrovska[1]*, Mihajlo Petrovski[1], Jasna Petrovska[2]

[1]UNIVERZITET „GOCE DELČEV", FAKULTET MEDICINSKIH NAUKA, ŠTIP, REPUBLIKA SEVERNA MAKEDONIJA
[2]UNIVERZITET „SVETI ĆIRILO I METODIJE", STOMATOLOŠKI FAKULTET, SKOPLJE, REPUBLIKA SEVERNA MAKEDONIJA

[1]FACULTY OF MEDICAL SCIENCES, GOCE DELCEV UNIVERSITY, STIP, NORTH MACEDONIA
[2]UNIVERSITY SS. CYRIL AND METHODIUS, FACULTY OF DENTISTRY, SKOPJE, REPUBLIC OF NORTH MACEDONIA

Sažetak

Uvod: *Različiti ortodontski aparati kao što su headgear i facijalne maske preporučuju se pacijentima u periodu rasta sa skeletnom malokluzijom III klase koju karakteriše maksilarni retrognatizam među umerenim do teškim slučajevima. Za većinu pacijenata sa malokluzijom III klase u ranoj mešovitoj denticiji ili u kasnoj mlečnoj denticiji Delerova (Delaire) facijalna maska predstavlja uobičajen izbor.*
Cilj: *S obzirom na navedene faktore i na sve veći značaj estetike u savremenom društvu, osnovni cilj ovog istraživanja bila je analiza relevantnih aspekata upotrebe facijalne maske u lečenju malokluzije III klase. Da bi glavni cilj istraživanja bio ostvaren, pregledana je odgovarajuća literatura. Delerova facijlna maska obično se koristi za protrakcije maksile.*
Zaključak: *Pojedini autori preporučuju ranu upotrebu facijalne maske budući da je efikasnija u ranom vremenu tretmana. Druge studije pak ne ukazuju na vezu između efekta protrakcije maksilarne facijalne maske i vremena tretmana. Princip maksilarne protrakcije podrazumeva primenu sile zatezanja na cirkum-maksilarne šavove i stimulaciju apozicije kostiju u oblastima šavova. Većina autora zabeležila je pozitivan efekat tretmana maskom za lice, uz značajno poboljšanje skeletnih parametara, kao i nepostojanje značajne razlike između ekspanzionog/neekspanzionog tretmana. Moglo bi se zaključiti da efekti lečenja malokluzije III klase maskom za lice u velikoj meri zavise od poznavanja bioloških, ortopedskih i kliničkih aspekata njihove upotrebe.*

Ključne reči: *facijalna maska, Deler, malokluzija III klase, lečenje malokluzije III klase*

Abstract

Introduction*: Different orthodontic appliances like reverse headgear and face masks are recommended for patients in the growing period with skeletal Class III malocclusion characterized by maxillary retrognathism, among moderate to severe cases. For most patients with Class III malocclusion seen in the early mixed dentition or late deciduous dentition, a Delaire face mask is the customary choice.*
Aim: *Taking into account the aforementioned factors, as well as the growing importance of aesthetics in modern society, the main goal of this research was to analyse the relevant aspects of using face masks in the treatment of Class III malocclusion. Adequate literature research was performed to fulfil the main goal. Delaire face mask is commonly used for protraction of the maxilla.*
Conclusion: *Some authors recommend early usage of face masks because they are more efficient in early treatment time and other studies do not show the relationship between the effect of maxillary face mask protraction and treatment timing. The principle of maxillary protraction is to apply tensile force on the circummaxillary sutures and stimulate bone apposition in the suture areas. Most of the authors conclude a positive effect of face mask treatment with significant improvement of skeletal parameters, and no significant difference between expansion/nonexpansion treatments. In conclusion, we can note that the effects of the treatment of Class III malocclusion with face masks largely depend on the knowledge of biological, orthopaedic and clinical aspects of their usage.*

Key words: *face mask, Delaire, Class III malocclusion, Class III malocclusion treatment*

Corresponding author:
Olivera Terzieva-Petrovska,DDM
Nikola Rusunski St. 6/2−8
1000 Skopje
Republic of North Macedonia
Email:olivertarzieva@yahoo.com

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Uvod

S obzirom na to da malokluzija III klase najviše utiče na dentofacijalni izgled i da su njene posledice u pogledu estetike izuzetno negativne, adolescenti sa ovakvim anomalijama percipiraju se kao „ružni" i odbačeni su od strane društva u svakodnevnom životu. Ovo ima uticaja i na njihovu psihu: razvijaju negativne emocije i imaju nizak nivo samopouzdanja, koji se uglavnom ne menja ni nakon urađene korektivno-estetske hirurške intervencije.

Kod pacijenata sa skeletnom malokluzijom III klase sa maksilarnim retrognatizmom preporučuje se upotreba različitih funkcionalnih ortodontskih aparata, kao što su *headgear* i facijalne maske. Kada je reč o terapijskim modalitetima, treba napomenuti da se kod osoba sa blagim do umerenim promenama preporučuje ortodontski kamuflažni tretman, kao i da se u težim slučajevima obično preporučuje ortognatska hirurgija. Hirurgija ove vrste poremećaja, posebno kod osoba sa teškom malokluzijom, jedini je pristup u lečenju posledica abnormalnosti skeleta koje nastaju zbog maksilarnog retrognatizma. Međutim, ovakav tretman povezuje se sa brojnim dodatnim rizicima, dok izvođenje ovih intervencija iziskuje znatno veće troškove.

U poslednje tri decenije, facijalne maske postale su omiljene među ortodontima u lečenju slučajeva u kojima je potrebno stimulisati rast maksile. Delerova (Delaire) maska za lice je tako najčešći izbor u slučajevima malokluzije II klase u ranoj mešovitoj ili kasnoj mlečnoj denticiji[1]. Iako je moguće da tretman Delerovom maskom za lice izazove promene u maksilarnom skeletu kod mladih ljudi i adolescenata, neophodno je da ovaj tretman bude dopunjen ortodontskom kamuflažom ili ortognatskom hirurgijom.

Što se rezultata upotrebe facijalne maske u terapiji tiče, valja istaći da određene kliničke studije ukazuju na brojne učinke koji mogu biti postignuti u pogledu trajnog smanjenja količine rasta mandibule. Naprotiv, ustanovljeno je da će rast šavova biti podstaknut u toku njihove upotrebe. Iz ovih razloga, a prvenstveno kao rezultat relativnog mandibularne prognatizma, prevashodno zbog nedostatka vilice umesto protrakcije vilice, misli se da je Delerova maska za lice takođe tretman alternativa za sofisticirana malokluzija III klasa. Naime, iz navedenih razloga, a pre svega zbog relativnog mandibularnog prognatizma, prevashodno zbog maksilarnog deficita, a ne maksilarne protrakcije mandibule, većina autora smatra da ovakva maska za lice može biti tretman izbora za malokluziju III klase.

Introduction

Class III malocclusion most importantly affects the dentofacial look and because of this extraordinarily negative aesthetic result, adolescents with such anomalies are perceived as "ugly" and socially rejected in their everyday life. Because of this, they psychologically develop negative emotions and possess low vanity, which generally remains even when the corrective-aesthetic surgical intervention is performed.

In patients with skeletal malocclusion class III with maxillary retrognathism, the use of various functional orthodontic appliances such as reverse headgear and face masks is recommended. Concerning the therapeutic modalities, it should be noted that in persons with mild to moderate changes, it is recommended to carry out orthodontic camouflage treatment, whereas in severe cases, orthognathic surgery is usually recommended. Surgery of this kind of disorder, particularly in persons with a severe malocclusion, is the sole approach of treatment for the sequelae of skeletal abnormalities that occur because of maxillary retrognathism. However, this kind of treatment is related to considerable additional risks and performing these interventions is related to considerably higher costs.

In the last 3 decades, facial masks became well-liked among orthodontists for treatment in cases where it is necessary to stimulate the growth of the maxilla. Delaire facial mask is so the most common choice in cases of Class II malocclusion within the early mixed or late deciduous dentition[1]. Treatment with Delaire facial mask is also possible to cause changes in the maxillary skeleton in young people and teenagers, however, these people need to supplement this treatment with orthodontic camouflage or orthognathic surgery.

Regarding the therapeutic effects of facial masks, some clinical studies suggest that they can lead to a permanent reduction in mandibular growth. However, they may also stimulate sutural growth. For these reasons and primarily as a result of relative mandibular prognathism, predominantly caused by jaw deficiency rather than jaw protraction, many authors believe that Delaire facial mask may be the treatment of choice for class III malocclusion.

Taking into consideration these facts, furthermore, because of the growing importance of aesthetics in our society, the main goal of this study was set—to make an analysis of the relevant aspects of using face masks in the treatment of Class III malocclusion.

S obzirom na sve navedene činjenice i na činjenicu da je značaj estetike u našem društvu sve veći, osnovni cilj ove studije bio je da se izvrši analiza relevantnih aspekata upotrebe facijalne maske u lečenju malokluzije III klase.

Da bi glavni cilj bio ostvaren, analizirana je odgovarajuća literatura. Izvori podataka korišćeni u ovoj studiji dobijeni su iz baze *PubMED*, koja se upotrebljava češće od svih drugih naučnih baza podataka. Svi korišćeni podaci iz literature prethodno su bili objavljeni u recenziranim publikacijama i časopisima. Većina članaka korišćenih za ovaj pregled literature objavljena je na engleskom jeziku i nastala je u poslednje dve decenije, tj. u periodu od 2004. do 2022. godine.

Smatramo da se ovim pregledom literature može pružiti važna teorijska podrška mogućnostima i kliničkim primenama upotrebe ovakvog aparata za maksilnu protrakciju i efektima koji rezultiraju povoljnom promenom skeletnog odnosa u korekciji malokluzije III klase.

Efekti Delerove maske za lice

Prema mišljenju većine ortodonata, adekvatno lečenje skeletne malokluzije III klase je najteže, prvenstveno zbog nepredvidivog potencijala rasta maksile u kombinaciji sa nepovoljnim rastom mandibule, ali i zbog konkavnog srednjeg profila. U vezi sa načinom na koji se ova malokluzija javlja primećeno je da su u oko 75% slučajeva skeletne malokluzije III klase uzrokovane maksilarnim retrognatizmom ili kombinacijom maksilarnog retrognatizma i mandibularnog prognatizma. Na osnovu činjenice da malokluziju III klase uglavnom karakteriše hipoplazija maksilarnog tkiva, neminovno se nametnula potreba za korišćenjem uređaja koji bi stimulisali rast maksilarnog tkiva. Danas postoje brojne tehnike za efikasnu protruziju maksile, zajedno sa upotrebom facijalne maske ili direktnom silom koja se primenjuje na ankilozirane primarne očnjake.

Malokluzija III klase je bolest koja ima multifaktorsku etiologiju, uključujući brojne genetske i ekološke uzroke[2]. Budući da ova anomalija ima različite uticaje na skeletna i zubna tkiva, neophodno je poznavanje njenih etioloških faktora. Konačna dijagnoza skeletne malokluzije III klase postavlja se na osnovu nekoliko kriterijuma opisanih u savremenoj literaturi. Tu spadaju: 1. pozitivna porodična anamneza; 2. odgovarajući cefalometrijski parametri, kao što su opadajući SNA ugao, negativan ANB ugao, mandibularna protruzija, tup gonijalni ugao i velika niža prednja visina

Adequate literature analysis was performed to fulfil the goal. Sources of data used in this study were obtained from the foremost used of all scientific databases—PubMED. Most of the articles used for this literature review have been previously published in English, in peer-reviewed publications and journals and cover the period from the last two decades, 2004 to 2022.

We believe that this review of the literature can offer vital theoretical support for the possibilities and clinical applications of the usage of this kind of maxillary protraction appliance and effects that result in a favourable change in the skeletal relationship for the correction of class III malocclusion.

Effects of Delaire face mask

According to most orthodontists, adequate treatment of skeletal Class III malocclusion is the most difficult primarily because of the unpredictable growth potential of the maxilla combined with unfavourable mandibular growth, as well as because of the concave midfacial profile. Regarding the way this malocclusion occurs, it can be noted that in about seventy-five percent of skeletal class III malocclusions, they are caused by maxillary retrognathism or a combination of maxillary retrognathism and mandibular prognathism. Based on the fact that Class III malocclusion is predominantly characterized by maxillary hypoplasia, the need to start using devices that would stimulate maxillary growth was inevitably imposed. To date, many techniques are delineated for the effective extension of the maxilla, together with the usage of a face mask or chin cup or through direct force applied to ankylosed primary canines.

Class III malocclusion is a disease that has a multifactorial aetiology including numerous genetic and environmental causes[2]. Because of the many effects caused by this anomaly on the skeletal and dental tissues, it is necessary to know the etiological factors of this disorder. The definitive diagnosis of skeletal class III is made based on several criteria described in the contemporary literature such as 1. positive family history; 2. appropriate cephalometric parameters such as decreasing SNA angle, negative ANB angle, mandibular protrusion, obtuse gonial angle, and large LAFH (lower anterior facial height); 3. determining the correlation between normal centric position with the habitual position; and 4. determining the incisal relationship[3].

Because the facial look and profile of class III malocculusion are the main complaints of patients, early treatment of this disorder is of enormous importance.

lica (engl. *lower anterior facial height* – LAFH); 3. utvrđivanje korelacije između normalnog centričnog položaja i uobičajenog položaja; 4. utvrđivanje incizalnog odnosa[3].

Pošto se pacijenti sa malokuluzijom III klase često žale na izgled i profil lica, rano lečenje ovog poremećaja ima ogroman značaj. Osnovni cilj ranog lečenja jeste da se omogući pravovremena korekcija profila lica, koja sukcesivno utiče na razvoj psihosocijalnog blagostanja i izgleda pacijenta, posebno u adolescentskim godinama. Kao što je prethodno pomenuto, pacijenti sa skeletnom III klase koji su propustili priliku za blagovremenu ranu modifikaciju rasta u tinejdžerskom periodu imaju brojne socijalne i funkcionalne anomalije[4-6]. Stoga, rano lečenje je veoma važno i takvim pacijentima može ponuditi znatno veći kvalitet života u godinama kada su najranjiviji, posebno u vezi sa izgledom[7].

Delerova maska za lice najčešće je korišćeni uređaj za maksilarnu protrakciju. Čaše za bradu i čelo služe za ekstraoralno sidrenje ovog uređaja. Jedan od značajnijih negativnih efekata ovog uređaja ogleda se u tome da može onemogućiti nošenje naočara ili ometati spavanje tokom terapije. Peti (Petit) je modifikovao Delerovo lice 1983. godine povezujući čelo i bradu teškom čeličnom šipkom[8].

U literaturi postoje kontroverze u vezi sa tim koji je trenutak idealan za primenu i korišćenje ovog uređaja u terapiji. Jedna grupa autora ističe da rano lečenje najprikladnije utiče na adekvatan rast prednjeg dela maksilarnog dela. Stoga, ovi autori ukazuju na to da je rana upotreba maski za lice i ekspanzione terapije značajno efikasnija ako se primenjuju ranije u detinjstvu[9,10]. S druge strane, postoji grupa autora koja tvrdi suprotno – da ne postoji korelacija između protrakcije maksilarne maske za lice i vremena tretmana[11-14].

Na osnovu brojnih višegodišnjih naučnih istraživanja, u savremenoj ortodonciji smatra se da je najprikladnija terapija za skeletnu III klasu ona koja se izvodi u dve etape. U prvoj fazi, aparat se koristi za proširenje maksilarnog dela, sve dok se ne postigne željena poprečna širina. Prema većini studija, prvi korak ne podrazumeva samo povećanje poprečne dimenzije nepca već i otvaranje šavova srednjeg kompleksa lica i pojačavanje protrakcionog efekta maske za lice u sledećoj fazi[12,15-17]. U sledećoj fazi, maska za lice koristi se kako bi se maksilarni kompleks unapredio.

The main goal of early treatment is to permit timely correction of the facial profile, which successively affects the development of the patient's psychosocial well-being and look, particularly throughout their adolescent years. As antecedently mentioned, patients with skeletal Class III who missed the opportunity for timely early growth modification in the teenage period have numerous social and functional anomalies[4–6]. Therefore, early treatment is of the greatest importance and it may offer such patients a considerably higher quality of life throughout the years when they are most vulnerable especially regarding their appearance[7].

Delaire face mask is the most commonly used device for maxillary protraction. The chin and forehead cups are used for extraoral anchoring of this device. One of the more significant negative effects that this device provides is that it can be impossible to wear glasses or disturb sleep during the therapy. Petit modified Delaire face mask in 1983 by connecting the forehead and a chin pad with a heavy steel rod[8].

There are controversial aspects in the literature regarding what is the ideal timing for applying and using this device in therapy. One group of authors points out that early treatment has the most appropriate effect on the adequate growth of the maxillary anterior part. Therefore, these authors indicate that the early use of face masks and expansion therapy is significantly more effective if applied earlier in childhood [9, 10]. In contrast, there is a group of authors who claim the exact opposite, that there is no correlation between the maxillary face mask protraction and the treatment time[11–14].

In contemporary orthodontics, based on numerous long-term scientific types of research, it is considered that the most appropriate therapy for skeletal Class III is if it is performed in two stages. In the first stage, the appliance is used for maxillary expansion until the desired transverse width is achieved. According to the majority of studies, the first step is not only to increase the transverse dimension of the palate but also to open the sutures of the midface complex and to amplify the protraction effect of the face mask in the next stage[12,15–17]. In the next phase, the face mask is used to get the maxillary complex advanced. It must be noted, however, that this type of treatment remains limited to deciduous or early mixed dentition. It has been noted that postero-anterior displacement causes more dental effects after this period than on different skeletal elements[18,19].

Međutim, mora se pomenuti da je ova vrsta lečenja ograničena na mlečnu ili ranu mešovitu denticiju. Primećeno je da posle ovog perioda postero-anteriorno pomeranje izaziva više dentalnih efekata nego na različitim elementima skeleta[18,19].

Većina autora smatra da je standardna terapija za malokluziju III klase koja je blaga do umerena kod pacijenata u periodu rasta maksilarna protrakcija radi korekcije deficita maksile. Iako su aspekti maksilarne komponente skeletnih modela III klase dobro poznati, mora se istaći da je razumevanje terapijskog uticaja na donju vilicu u toku rasta prilično ograničeno i da ima brojne nuspojave na temporomandibularnom zglobu.

Veoma je teško izvesti poređenje različitih cefalometrijskih varijabli, pre svega zbog velike promenljivosti parametara koji se koriste u različitim studijama. Ipak, kao i većina studija, ovaj pregled literature fokusira se na najčešća merenja i parametre: SNA ugao, SNB ugao, ANB ugao, Vitsova (Wits) analiza, mandibularna ravan, palatinalna ravan, ugao gornjeg sekutića i ugao donjeg sekutića. U studiji Foerscha i sar.[20] primećene su ukupne promene ugla SNA od 2,47°, promene ugla SNB od -1,42°, promene ugla ANB od 3,72°, promene ugla mandibularne ravni od 1,85°, promene ugla palatinalne ravni od -0,91° i promene ugla gornjeg sekutića od 5,17°. Prema njihovim rezultatima, u pogledu skeletnih parametara, pozitivni efekti tretmana predstavljeni antero-posteriornom repozicijom mandibule i sagitalnim maksilarnim pomeranjem napred mogu se uočiti kod pacijenata koji koriste masku za lice. Rezultati ovih autora takođe su pokazali da postoji blaga rotacija mandibule u smeru kazaljke na satu, kao i rotacija maksilarnog planuma u smeru kazaljke na satu. U istom preglednom radu navodi se da su efekti tretmana maske za lice sa aktivacijom aparata za brzo proširenje maksilarnog tela, procenjeni na osnovu sedam studija, prikazali ukupne promene ugla SNA od 1,71°, promene ugla SNB od -1,17°, promene ugla ANB od 2,28°, promene ugla mandibularne ravni od 1,61°, promene ugla palatinalne ravni od -0,71° i promene ugla gornjeg sekutića za 2,51°. Takođe, u okviru ove studije utvrđene su manje promene u ugaonosti sekutića od -1,99° i promene u Vits analizi od 0,52 mm kada je ekspanzija bila izvršena u periodu pre tretmana maskom za lice.

Prema Westwood i sar.[21], adekvatna procena promena koje nastaju posle tretmana facijalnom maskom treba da uključi dugoročnu procenu lečenih pacijenata, naročito nakon napredovanja rasta u pubertetu, kako bi se dugoročni efekti mogli pretpostaviti i utvrditi.

Most authors consider that the standard therapy for mild to moderate Class III malocclusion in growing patients is maxillary protraction to correct the deficient maxilla. Although aspects of the maxillary component of Class III skeletal models are well known, it must be noted that the understanding of the therapeutic impact on the mandible during growth is quite limited with numerous undesirable side effects occurring at the temporomandibular joint.

Regarding the possibility of comparing different cephalometric variables, it must be noted that it is very difficult, primarily due to the high variability of the parameters used in the different studies. However, as most studies, this literature review focused on the most common measurements and parameters: SNA angle, SNB angle, ANB angle, Wits' analysis, mandibular plane, palatal plane, upper incisor angulation and lower incisor angulation. In a study by Foersch et al.[20], it was observed that there were changes in the following angles: total SNA angle changed by 2.47°, SNB angle changed by -1.42°, ANB angle changed by 3.72°, mandibular plane angle changed by 1.85°, palatal plane angle changed by -0.91° and upper incisor angulation changed by 5.17°. According to their results, in the context of skeletal parameters, positive effects of treatment represented by anteroposterior reposition of the mandible and sagittal maxillary forward movement can be observed in patients using a face mask appliance. The results of these authors also showed that there was a slight clockwise rotation of the mandible and a counterclockwise rotation of the maxillary planum. In the same review paper, it was noted that when a face mask treatment was combined with the activation of a rapid maxillary expansion appliance, based on seven studies, the following total changes were observed: SNA angle changed by 1.71°, SNB angle changed by -1.17°, ANB angle changed by 2.28°, mandibular plane angle changed by 1.61°, palatal plane angle changed by -0.71°, upper incisor angulation changed by 2.51°. Additionally, within this study, smaller changes in incisor angulation of -1.99° and changes in Wits analysis of 0.52 mm were found when the expansion was performed during the period before the face mask treatment.

According to Westwood et al.,[21] an adequate evaluation of the changes that occur after treatment with a face mask should include a long-term evaluation of the treated patients, especially after the pubertal growth spurt, so that long-term effects can be

Pomenuti autori istakli su i da su uočene značajne povoljne promene i na maksilarnoj i na mandibularnoj skeletnoj komponenti. Međutim, prilikom poređenja sa nelečenom kontrolnom grupom sa malokluzijom III klase može se primetiti da se u periodu posle tretmana karakteristike rasta III klase uglavnom vraćaju nakon terapije maskom za lice. Upravo zbog toga, nakon procene celokupnog tretmana i promena nakon tretmana, može se jasno zaključiti da se korisne promene u skeletnom odnosu mogu postići samo u toku aktivne terapije maskom za lice i da se kasnije zubne komponente mogu održati u pomenutom odnosu pomoću fiksnih aparata.

Osnovni princip delovanja ovog uređaja zasniva se na izvođenju maksilarne protrakcije; pritom se primenjuje sila koja dovodi do istezanja cirkum-maksilarnih šavova i na taj način stimuliše stvaranje i rast kosti u predelima šavova. Potom, efekat facijalne maske predstavlja stvaranje sile koja je stalno usmerena na prednju stranu maksile, uzrokujući njeno produženje. Zapaženo je da primenom ove vrste konstantnih protrakcionih sila dolazi do značajnog prednjeg pomeranja maksilarnih šavova, koje je praćeno i osnovnim histološkim promenama u cirkum-maksilarnim šavovima. Ovo maksilarno kretanje može biti olakšano brzim poprečnim proširenjem maksilarnog tkiva. Može se zapaziti da delovanjem ovog uređaja dolazi do izraženog poremećaja suturalne artikulacije maksile do preostalih devet kostiju kraniofacijalnog kompleksa, što omogućava reakciju na sile protrakcije[22].

Promena skeleta koja se kod osoba sa malokluzijom III klase javlja u toku ortodontskog lečenja maskama za lice prvenstveno dovodi do promene veličine disajnih puteva. Lee i sar.[23] istakli su da skeletne promene koje se javljaju tokom tretmana malokluzije III klase maskom za lice značajno utiču na veličinu disajnih puteva. Podaci koji svedoče o promenama u orofaringealnim i nazofaringealnim dimenzijama nakon terapije maskom za lice takođe se mogu pronaći u literaturi[24,25]. S druge strane, određeni autori, Hiiama i sar.[26] na primer, nisu primetili promene u dimenzijama disajnih puteva. Saijinsu i sar.[27] su u jednoj od svojih studija uočili značajne promene vezane samo za veličinu nazofarinksa. Međutim, kako skoro svi autori ističu, maksilarna protrakcija sa brzom ekspanzijom maksile[26] ili bez nje[24] dovodi do statistički značajnog povećanja dimenzija disajnih puteva. Većina autora saglasna je sa tim da postoji značajan pozitivan efekat tretmana facijalnom maskom, i to sa

assumed and determined. According to the same authors, significant favourable changes were observed in both maxillary and mandibular skeletal components. However, compared to the untreated control group with Class III malocclusion, it can be noted that in the post-treatment period, Class III growth characteristics generally return following face mask therapy. Precisely because of this, after the evaluation of the overall treatment and the changes after the treatment, it can be concluded that the amount of beneficial changes in the skeletal relationship can be obtained only during the active therapy with a face mask and in the later phase using the fixed appliances can maintain the dental components in the given ratio.

The basic principle of activity of this device is based on the performance of maxillary protraction, during which a force is applied that leads to the stretching of the circummaxillary sutures and thus stimulates the creation and growth of bone in the areas of the sutures. From here, the effect of the face mask is to create a force that is constantly directed at the frontal side of the maxilla, causing it to protract. With the application of this type of constant protraction force, a significant anterior displacement of the maxillary sutures has been observed, which is also accompanied by basic histological changes in the circummaxillary sutures. This maxillary movement can be facilitated by rapid maxillary transverse expansion. Through the action of this device, it can be observed that there is a pronounced disruption of the sutural articulation of the maxilla to the remaining nine bones of the craniofacial complex, enabling a reaction to the forces of protraction[22].

The skeletal change that occurs in individuals with Class III malocclusion during orthodontic treatment with facial masks primarily leads to a change in the size of the airway. According to Lee et al.[23], the skeletal changes that occur during face mask treatment of class III malocclusion significantly affect airway size. Data on changes in both oropharyngeal and nasopharyngeal dimensions after face mask therapy can also be noted in the literature[24,25]. In contrast, certain authors such as Hiyama et al.[26] observed no changes in airway dimensions. Saijinsu et al.[27] in one of their studies observed significant changes only in the size of the nasopharynx. However, maxillary protraction with[26] or without[24] rapid maxillary expansion leads to statistically significant increases in airway dimensions according to almost all authors.

znatnim poboljšanjem skeletnih parametara; pritom, nije primećena značajna razlika između slučajava sa urađenim ekspanzionim tretmanom i onima bez njih, osim pojave smanjenih dentalnih neželjenih efekata ugaonost gornjeg sekutića kada se vrši dalja ekspanzija. Međutim, prema studiji Tofola i sar.[2], upotreba ekspanzivne terapije poboljšava efekat ekspanzije u odnosu na vreme lečenja. Isti autori su na osnovu analize devetnaest članaka u kojima je bio obuhvaćen period od pet godina naveli da stopa uspešnosti lečenja ortopedskim maskama za lice iznosi 76%.

Potreba za transverzalnom ekspanzijom kod pacijenata klase III pretežno je povezana sa prisustvom dentoalveolarnih abnormalnosti u poprečnoj dimenziji, kao što je prisustvo ukrsnih ugriza ili malokluzije koji se karakterizuju sa okluzalnim odnos ivice na ivice. Međutim, primećeno je da nije bilo značajnog poboljšanja maksilarne protrakcije kada je izvršena dodatna ekspanzija. Spontano poboljšanje bočnih ukrštenih ugriza kod pacijenata primećeno je nakon učinjene maksilarne protrakcije, prvenstveno zato što se ovako formiran maksilarni luk vrlo dobro uklapa sa manjim mandibularnim pandanom[20].

U većini studija nije se ispitivala efikasnost tretmana maskama za lice kod veoma mladih pacijenata sa mlečnim zubima. Lee i sar.[28] istakli su da je u periodu nakon korekcije malokluzije III klase terapijom koja je podrazumevala masku za lice primećena tendencija recidiva u periodu posmatranja. Maksilarna protrakcija izazvana maskama za lice bez brze maksilarne ekspanzije može biti manje stabilna kod veoma mladih pacijenata. Isti ovi autori istakli su da nije zabeležena značajna razlika u promenama skeleta prilikom poređenja dveju grupa pacijenata (pacijenti lečeni maskom za lice sa brzom maksilarnom ekspanzijom i bez nje) u celokupnom periodu.

Ipak, na kraju se mora napomenuti da sve pregledane studije pokazuju samo određene homogenosti u pogledu kvaliteta, prvenstveno zbog različitih statističkih metoda i korišćenih cefalometrijskih varijabli, ali i zbog različitih starosnih grupa koje su bile uključene u ispitivanje. Sve to je u priličnoj meri otežalo analizu i poređenje rezultata dobijenih u studijama. S druge strane, na uporedivost mogu uticati i nivo sile i trajanje lečenja i neki dodatni nekontrolisani faktori, kao što su individualne razlike u rastu.

Most of the authors agree that there is a significant positive effect of treatment with a face mask with a significant improvement in skeletal parameters, with no significant difference observed between whether or not expansion treatment was performed, except for the appearance of reduced dental side effects of the angulation of the upper incisor when further expansion is performed. However, according to a study by Tofol et al.[2] the use of expansive therapy improves the protracting effect with respect to treatment time. The same authors describe a 76% success rate for treatment with orthopaedic face masks, based on an analysis of 19 articles over a 5-year follow-up period.

The need for transverse expansion in Class III patients is predominantly correlated with the presence of dentoalveolar abnormalities in the transverse dimension such as the presence of crossbites or edge-to-edge occlusion. However, it was noted that there was no significant improvement in maxillary protraction when additional expansion was performed. After performing maxillary protraction, spontaneous improvement of lateral crossbites was observed in patients. This occurs because the maxillary arch formed in this way fits well with its smaller mandibular counterpart[20].

Most studies have not investigated the efficacy of face mask treatment in very young primary dentition patients. According to Lee et al.[28] in the period after the correction of Class III malocclusion with a face mask therapy, a tendency to relapse was observed during the observation period. Maxillary protraction induced by face masks without rapid maxillary expansion may be less stable in very young patients. These same authors noted that no significant difference in skeletal changes was observed between the two groups (patients treated with a face mask with and without rapid maxillary expansion) over the overall time period.

But in the end, it must be noted that all the retrieved studies show only certain homogeneities in terms of study quality, primarily due to different statistical methods and cephalometric variables used, as well as the different age groups involved, which makes it rather difficult to analyse properly and compare their findings. On the other hand, the level of force and the duration of treatment and some additional uncontrolled factors, such as individual differences in growth, may affect comparability.

Zaključak

Na kraju, možemo primetiti da efekti lečenja malokluzije III klase facijalnom maskom u velikoj meri zavise od poznavanja bioloških, ortopedskih i kliničkih aspekata njihove upotrebe.

Conclusion

In conclusion we can note that the effects of the treatment of Class III malocclusion with face masks largely depend on the knowledge of biological, orthopaedic and clinical aspects of their usage.

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ORALNO HIRURŠKO ZBRINJAVANJE PACIJENATA OBOLELIH OD HEMOFILIJE

ORAL SURGICAL TREATMENT OF PATIENTS SUFFERING FROM HAEMOPHILIA

Miloš R. Tijanić[1,2], Simona M. Stojanović[1,2], Kristina N. Burić[1,3], Branislava B. Stojković[1,4]

[1]UNIVERZITET U NIŠU, MEDICINSKI FAKULTET, NIŠ, SRBIJA
[2]KLINIKA ZA DENTALNU MEDICINU, ORALNA HIRURGIJA,NIŠ, SRBIJA
[3]STUDENT DOKTORSKIH AKADEMSKIH STUDIJA
[4]KLINIKA ZA DENTALNU MEDICINU, PREVENTIVNA I DEČJA STOMATOLOGIJA, NIŠ, SRBIJA

[1]UNIVERSITY OF NIŠ, FACULTY OF MEDICINE, NIŠ; SERBIA
[2]CLINIC OF DENTAL MEDICINE, DEPARTMENT OF ORAL SURGERY, NIŠ, SERBIA
[3]PHD STUDENT
[4]CLINIC OF DENTAL MEDICINE, DEPARTMENT OF PREVENTIVE AND PAEDIETRIC DENTISTRY, NIŠ, SERBIA

Sažetak

Uvod: *Hemofilija je jedno od najčešćih hemoragijskih oboljenja iz grupe koagulopatija i nastaje kao posledica deficita faktora ogovornih za I fazu koagulacije.*
Cilj: *Cilj ovog informativnog rada bio je da se ukaže na principe oralnohirurškog tretmana pacijenata sa hemofilijom.*
Materijal i metode: *Analizirana je dostupna literatura kako bi se ukazalo na osnovne karakteristike hemofilije (na kliničku manifestaciju, mogućnosti lečenja i profilakse oboljenja), sa posebnim osvrtom na specifičnosti i principe stomatološkog oralnohirurškog tretmana obolelih od hemofilije.*
Zaključak: *Lečenje pacijenata sa hemofilijom se smatra jednim od najrizičnijih u svakodnevnoj stomatološkoj praksi. Uprkos tome, stomatološke intervencije se mogu uspešno i bezbedno obavljati. Međutim, stomatolog mora biti upoznat sa prirodom bolesti, njenim simptomima i težinom kliničke slike. Dalje, stomatolog treba da zna kakvu terapiju pacijent prima za lečenje hemofilije, da li je pacijentu dijagnostikovan inhibitor faktora koagulacije i da li pacijent ima prateće bolesti sa posebnim osvrtom na moguće zarazne bolesti. Uz to, ključ uspešne i bezbedne intervencije leži u dobro planiranom preoperativnom, perioperativnom i postoperativnom lečenju pacijenata sa hemofilijom.*

Ključne reči: *Hemofilija, Terapija, Oralnohirurški tretman*

Abstract

Introduction: *Haemophilia is one of the most common haemorrhagic diseases from the group of coagulopathies and results from a deficiency of factors responsible for the first phase of coagulation.*
Aim: *This informative paperwork aims to highlight the principles of oral surgical treatment of patients with haemophilia.*
Material and methods: *The available literature was analysed to indicate the basic characteristics of haemophilia (clinical manifestation, possibilities of treatment and prophylaxis of the disease) with special reference to specificity and principles of dental oral surgical treatment of patients with haemophilia.*
Conclusion: *The treatment of patients with haemophilia is considered one of the riskiest in everyday dental practice. Despite this, dental interventions can be successfully and safely performed. However, the dentist must be acquainted with the nature of the disease, its symptoms and the severity of the clinical picture. Furthermore, the dentist needs to know what kind of therapy the patient receives for the treatment of haemophilia, whether the patient has been diagnosed with inhibitors to the coagulation factor, and whether the patient has concomitant diseases with special reference to possible infectious diseases. Along with that, the key to a successful and safe intervention lies in a well-planned preoperative, perioperative and postoperative treatment of patients with haemophilia.*

Key words: *haemophilia, therapy, oral surgical treatment*

Corresponding author:
Asst. Prof. Miloš Tijanić, DDS, PhD
52 Dr. Zorana Djindjica Blvd., Niš, Serbia
E-mail: tijanicm@yahoo.com

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Uvod

Hemofilija je jedno od najčešćih hemoragijskih oboljenja iz grupe koagulopatija i nastaje kao posledica deficita faktora ogovornih za I fazu koagulacije. U najvećem broju slučajeva, hemofilija je nasledno oboljenje. Ima podataka i o stečenoj hemofiliji, koja se javlja kao posledica stvaranja autoantitela na faktore koagulacije.

Za ovu bolest zna se već vekovima; prema nekim podacima, poznata je više od 2000 godina. Arapski hirurg Abulcasis je u X veku opisao slučaj porodice u kojoj su muški članovi umirali i nakon najmanje povrede. Svi kasniji zapisi ukazuju na to da su stručnjaci zapazili da postoje hemoragijska oboljenja prisutna samo kod muškaraca. Hemofilija je poznata i kao „kraljevska bolest" – dovodila se u vezu sa kraljicom Viktorijom, koja je bila nosilac gena za hemofiliju, i njenim sinom Leopoldom, a prekoViktorijinih ćerki i sa mnogim nemačkim, španskim i ruskim kraljevskim porodicima, uključujući Romanove. U početku se hemofilija vezivala samo za deficit VIII faktora koagulacije, a onda je sredinom XX veka utvrđeno da hemofilija može nastati i kao deficit IX ili XI faktora koagulacije. Reč „hemofilija" prvi je upotrebio Johan Lukas Šenlajn u svojoj disertaciji odbranjenoj na Univerzitetu u Cirihu. Posredi je kovanica nastala od grčkih reči *hemo*, sa značenjem „krv", i *philia*, sa značenjem „ljubav". Genetski opis hemofilije prvi je dao dr Nase, koji je istakao da hemofiliju na svoje sinove prenose majke koje nisu bolovale od hemofilije[1-5].

Hemofilija je redak nasledni poremećaj koagulacije vezan za X hromozom, koji odlikuje nedostatak VIII faktora koagulacije (hemofilija A), odnosno IX faktora (hemofilija B). Opisana je i hemofilija C (nedostatak faktora XI), koja se prenosi autozomno-recesivno i uglavnom je prisutna u zajednici Jevreja Aškenaza. Ukupna učestalost hemofilija iznosi 1 : 10 000. Svetska zdravstvena organizacija (SZO) procenjuje da je broj muškaraca sa hemofilijom oko 1.125.000, s tim što kod većine bolest nije dijagnostikovana; među njima je i procenjenih 418.000 osoba sa teškim oblikom ove bolesti[1,6]. Hemofilija spada u grupu retkih bolesti i jedna je od četiri retke bolesti za koje u Republici Srbiji postoji nacionalni registar obolelih[7]. Najčešće se javlja hemofilija A (80% – 85%), koja se kod živorođene muške dece javlja u jednom od 5 000 slučajeva, a prati je hemofilija B, prisutna u jednom od 30.000 slučajeva.

Introduction

Haemophilia is one of the most common haemorrhagic diseases from the group of coagulopathies and results from a deficiency of factors responsible for the first phase of coagulation. In most cases, haemophilia is a hereditary disease. Acquired haemophilia, which occurs because of the formation of autoantibodies to coagulation factors, has also been described.

The disease has been known for many centuries, for even more than 2000 years according to some data. In the 10th century, the Arab surgeon Abulcasis described a case of a family in which male members died even after a minor injury. All subsequent records suggested that experts at the time noticed there were haemorrhagic diseases that affected men only. Haemophilia is also known as the "royal disease" given that it was associated with Queen Victoria, who was a carrier of the haemophilia gene, her son Leopold, and through her daughters with many German, Spanish and Russian royal families, including the Romanovs. In the beginning, haemophilia was associated only with coagulation factor VIII deficiency, but in the mid-20th century, it was established that the disease can also occur as a deficiency of coagulation factor IX or XI. The term "haemophilia" was first used by Johann Lucas Schönlein in his dissertation at the University of Zurich and is a coinage of the Greek words "hemo" meaning blood and "philia" meaning love. The genetic description of haemophilia was first given by Dr Nasse, who pointed out that haemophilia is completely transmitted by mothers who did not suffer from haemophilia to their sons[1-5].

Haemophilia is a rare inherited coagulation disorder linked to the X chromosome, characterized by a deficiency of coagulation factor VIII (haemophilia A) or factor IX (haemophilia B). Haemophilia C (factor XI deficiency), which is transmitted in an autosomal recessive manner and is mainly present among the Ashkenazi Jews, has also been described. The overall incidence of haemophilia is 1:10,000. The World Health Organization (WHO) estimates that the number of men with haemophilia is about 1,125,000, most of whom are undiagnosed, including an estimated 418,000 with a severe form of the disease[1,6]. It belongs to the group of rare diseases and is one of the four rare diseases for which there is a national register of patients in the Republic of Serbia[7].

Najređi oblik predstavlja hemofilija C, sa učestalošću 1 : 100 000 kod živorođene muške dece. Od hemofilije obolevaju uglavnom muškarci koji nasleđuju izmenjeni X hromozom od majke. Žene retko obolevaju od hemofilije; do toga može doći u slučajevima u kojima su oba X hromozoma izmenjena ili u slučajevima u kojima je jedan izmenjen, a drugi inaktivan. Žene sa jednim izmenjenim X hromozomom nazivaju se prenosiocima hemofilije[8].

Kliničke manifestacije hemofilije

Prvi znaci hemofilije uglavnom se otkrivaju u ranom detinjstvu. Primećuje se produženo vreme koagulacije koje nastaje kao rezultat potpunog nedostatka ili značajnog smanjenja određenog faktora koagulacije ili kvalitativno promenjenog faktora koagulacije, odnosno njegove koagulacione aktivnosti. Obično se javljaju neobjašnjive modrice kada dete puzi ili počinje da hoda ili nakon primanja medikamenata *per injectionem*.

Klinička manifestacija hemofilije zavisi od vrste hemofilije. Hemofiliju A karakterišu hemartroze, posebno u kolenima, skočnom zglobu, ramenu, laktovima i kuku, krvarenje u telesnim dupljama, potkožnom i mišićnom tkivu, kao i pojava krvi u mokraći. Mogu se javiti i sublingvalni i peritonzilarni hematomi kao urgentna stanja koja mogu ugroziti život. Hemofilija B uglavnom se manifestuje na isti način kao i hemofilija A. Hemofiliju C karakterišu krvarenje iz nosa, krvarenje posle povreda i hirurških intervencija, dok su spontana krvarenja izuzetno retka. Međutim, kliničke manifestacije hemofilije umnogome zavise od težine bolesti, koja se određuje na osnovu deficita faktora koagulacije. Za tešku hemofiliju (< 1 IU/dL (< 0,01 IU/mL) ili < 1% nivoa faktora koagulacije) tipična su spontana krvarenja u zglobovima, mišićima i unutrašnjim organima, za umerenu hemofiliju (1–5 IU/dL (0,01–0,05 IU/mL) ili 1% – 5% nivoa faktora koagulacije) povremena spontana krvarenja i produženo krvarenje posle manje traume ili hirurške intervencije, a za blagu formu hemofilije (5–40 IU/dL (0,05–0,40 IU/mL) ili od 5% do < 40% nivoa faktora koagulacija) teža krvarenja posle većih trauma ili hirurških intervencija; spontana krvarenja u ovom obliku retka su pojava[9].

Pacijenti sa hemofilijom imaju povećan rizik od smanjenja gustine kostiju[10]. Kod pacijenata sa umerenom i teškom formom hemofilije A hematomi pokazuju tendenciju

The most common is haemophilia A (80–85%) with a ratio of 1:5,000 of live-born male children, followed by haemophilia B with a frequency of 1:30,000, and haemophilia C with a frequency of 1:100,000 of live-born male children. Haemophilia mostly affects men who inherit an altered X chromosome from their mothers. Women rarely suffer from haemophilia, i.e., there are cases in which both X chromosomes are altered, or when one is altered and the other inactive. Women with one altered X chromosome are regarded as haemophilia carriers[8].

Clinical manifestations of haemophilia

The first signs of haemophilia are usually detected in early childhood in the form of prolonged coagulation time resulting from a complete lack or significant reduction of a certain coagulation factor or a qualitatively changed coagulation factor, i.e., its coagulation activity. Unexplained bruises usually occur when a child crawls or starts to walk or after receiving medication *per injectionem*.

The clinical manifestation of haemophilia depends on its type. Haemophilia A is characterized by hemarthroses, especially in the knees, ankles, shoulders, elbows and hips, bleeding in body cavities, subcutaneous and muscle tissue, and the appearance of blood in urine. Sublingual and peritonsillar haematomas can also occur and suggest urgent, life-threatening conditions. Haemophilia B generally manifests itself in the same way as haemophilia A, whereas haemophilia C is characterized by nosebleeds, bleeding after injuries and surgical interventions. Yet, spontaneous bleeding is extremely rare. However, clinical manifestations of haemophilia largely depend on the severity of the disease, which is determined by the deficiency of coagulation factors. Severe haemophilia (< 1 IU/dL (< 0.01 IU/mL) or < 1% of the coagulation factor level) is characterized by spontaneous bleeding in joints, muscles, and internal organs. Moderate haemophilia (1–5 IU/dL (0.01–0.05 IU/mL) or 1–5% of the coagulation factor level) is characterised by occasional spontaneous bleeding, prolonged bleeding after minor trauma or surgical intervention, whereas a mild form of haemophilia (5–40 IU/dL (0.05–0.40 IU/mL) or 5–< 40% of the coagulation factor level) is characterized by severe bleeding after major trauma or surgical interventions, and rare spontaneous bleeding[9].

Patients with haemophilia have an increased risk of decreased bone density[10].

progresivnog širenja u svim pravcima. Smatra se da u teške forme krvarenja spadaju hemartroze, krvarenja u mišićima i dubokim prostorima, kao i ona u sluzokoži usne duplje, nosa i genitourinarnog trakta, a u krvarenja opasna po život intrakaranijalna i gastrointestinalna krvarenja i krvarenja u predelu grla i vrata[11].

Poseban izazov i rizik predstavljaju pacijenti sa prisutnim inhibitorima faktora koagulacije. „Inhibitori" predstavljaju IgG aloantitela na egzogen FVIII ili FIX koja neutrališu funkciju unetih koncentrovanih faktora koagulacije. Najčešće se javljaju kod pacijenata sa teškim oblikom hemofilije, uglavnom hemofilije A. Rasa, nasleđe, forma bolesti, učestalost primanja i tip koncentrovanih faktora koagulacije predstavljaju potencijalno najvažnije faktore rizika za nastanak ovih inhibitora[12].

Terapijske mogućnosti u lečenju hemofilija

Osim zbrinjavanja akutnih krvarenja, kod pacijenata sa hemofilijom veoma je važna strategija profilakse, koja ima za cilj da smanji učestalost i intenzitet mogućih krvarenja i potrebu za hospitalizacijom pacijenta, a samim tim i da poboljša kvalitet života obolelih. Prema SZO, profilaksa može biti primarna i sekundarna, kontinuirana i privremena. Profilaktički tretman uglavnom počinje jednom ili dva puta nedeljno, a njegova učestalost povećava se dok se ne postigne puna primarna profilaktička doza, pre početka krvarenja u zglobovima ili drugih ozbiljnih krvarenja, u dobi od 12 do 18 meseci[1,13,14]. Na primer, u slučaju hemofilije A doza faktora VIII izračunava se telesnom težinom izraženom u kilogramima i množenjem sa željenim povećanjem faktora VIII i 0,5 jedinica/kg, a nivo faktora obično se meri od 15 do 30 minuta nakon primene da bi se proverila izračunata doza. Poluživot SHL FVIII iznosi oko 12 sati, dok za FIX iznosi od 18 sati do 24 sata. Koliko će profilaksa trajati i da li će biti prekinuta zavisi od samog pacijenta i njegovih simptoma[15,16].

Pedesetih godina prošlog veka u terapiji hemofilije koristila se sveže smrznuta plazma, a desetak godina kasnije počela je upotreba krioprecipitata. Liofilizovani faktori koagulacije iz plazme prvi put su upotrebljeni sedamdesetih godina prošlog veka. Premda se smatralo da oni predstavljaju revoluciju u terapiji hemofilije, mnogi pacijenti na ovoj

In patients with moderate and severe forms of haemophilia A, haematomas tend to progressively expand in all directions. It is generally considered that severe forms of bleeding include hemarthrosis, bleeding in muscles and deep spaces, mucous membranes of the oral cavity, nose and genitourinary tract, whereas life-threatening bleeding involves intracranial, gastrointestinal, and throat and neck bleeding[11].

Patients diagnosed with inhibitors of coagulation factors pose a special challenge and risk. "Inhibitors" represent IgG alloantibodies to exogenous FVIII or FIX that neutralize the function of concentrated coagulation factors. They most often occur in patients with severe haemophilia, mainly haemophilia A. Race, heredity, form of the disease, frequency of receiving and type of concentrated coagulation factors are potentially the most significant risk factors for the occurrence of these inhibitors[12].

Therapeutic possibilities in the treatment of haemophilia

In addition to treating acute bleeding in patients with haemophilia, a prophylaxis strategy, which aims to reduce the frequency and intensity of possible bleeding and the need for hospitalization, thus improving the quality of life of patients, is considered very important. According to the WHO, prophylaxis can be primary and secondary, continuous and temporary. In the beginning, the frequency of prophylactic treatment is usually once or twice a week, but it is increased until the full primary prophylactic dose is reached, before the onset of joint bleeding or other serious bleeding at 12–18 months of age[1,13,14]. For instance, in haemophilia A, the factor VIII dose is calculated by body weight in kilograms multiplied by the desired increase in factor VIII and 0.5 units/kg. The factor level is usually measured 15–30 minutes after administration to verify the calculated dose. The half-life of SHL FVIII is about 12 hours, whereas that of FIX amounts to 18–24 hours. How long the prophylaxis will last and whether it will be interrupted depends on the patients themselves and their symptoms[15,16].

Fresh frozen plasma was first used in haemophilia therapy in the 1950s, and ten years later the use of cryoprecipitates began. Freeze-dried coagulation factors from plasma were first used in the 1970s and were considered to have revolutionized haemophilia therapy.

terapiji bili su zaraženi HIV virusom ili hepatitisom C zbog kontaminacije, što je podstaklo dalja istraživanja i traganje za bezbednom i sigurnom terapijom hemofilije. Revoluciju u terapiji hemofilije unela je pojava rekombinantnog faktora VIII devedesetih godina prošlog veka, koja je terapiju hemofilije učinila znatno bezbednijom. Danas su dostupne četiri generacije rekombinantnog faktora sa produženim poluživotom ili bez njega; pritom, treća generacija rekombinantnog faktora danas se u mnogim zemljama smatra najprikladnijom[1]. Sem pomenutih, u terapiji hemofilije koriste se i antifibrinolitici (traneksamična kiselina – TXA, epsilon aminokapronska kiselina) i dezmopresin (DDAVP)[17-22].

Novi terapijski pristupi u lečenju hemofilije podrazumevaju gensku terapiju i terapiju preparatima koji ne sadrže faktore koagulacije, tj. terapiju monoklonskim antitelima. Preovladava stav da će genska terapija imati značajan doprinos u lečenju hemofilije. Odobrena je njena primena za hemofiliju A i B. Međutim, genska terapija u lečenju hemofilije za sada nije indikovana kod pacijenata sa sa oboljenjima jetre, deca, kao i pacijenti sa antitelima na faktor koagulacije[23]. Ograničavajući faktor nesumnjivo je i cena ovih preparata, koja je trenutno visoka. Ipak, treba pomenuti da se daje samo jedna doza. Međutim, danas se smatra da će preparati koji ne sadrže faktore koagulacije, odnosno monoklonska antitela, kakvi su npr. lekovi emicizumab, marstacimab, koncizumab, doneti pravu revoluciju u lečenju hemofilije. Naime, oni oponašaju funkciju aktiviranog molekula faktora koagulacije (ali ne liče strukturno ili imunološki na njih, pa inhibitori nemaju efekta) ili inhibiraju prirodne endogene antikoagulante (inhibitor aktivacije spoljašnjeg puta koagulacije – TFPI). Smatraju se bezbednim za upotrebu, imaju poluživot od četiri nedelje do pet nedelja i značajno smanjuju stopu krvarenja. Od svih navedenih monoklonskih antitela, emicizumab, koji se i najviše proučavao, za sada je pokazao najbolje rezultate[24,25]; trenutno je jedini odobren za kliničku upotrebu u najvećem broju zemalja. Njegova primena je u našoj zemlji odobrena kod pacijenata sa teškom formom hemofilije A i kod pacijenata sa inhibitorima. Marstacimab, koji je u završnoj fazi kliničkih ispitivanja, koristi se u profilaksi krvarenja kod pojedinaca sa teškom ili umerenom formom hemofilije A ili B, sa inhibitorima ili bez njih. Ovi preparati ne koriste se u tretmanu akutnih krvarenja.

However, due to contamination, many patients undergoing this therapy were infected with HIV or hepatitis C. This prompted further studies and a search for safe haemophilia therapy. The appearance of recombinant factor VIII in the 1990s brought about a revolution in the treatment of haemophilia and made it much safer. Nowadays, 4 generations of recombinant factor are available with or without extended half-life, with the third generation of recombinant factor now considered most suitable in many countries[1]. In addition, antifibrinolytics (tranexamic acid TXA, epsilon aminocaproic acid), and desmopressin (DDAVP) are also used in haemophilia therapy[17-22].

New therapeutic approaches in the treatment of haemophilia include gene therapy and therapy with preparations that do not contain coagulation factors—monoclonal antibodies. It is generally considered that gene therapy significantly contributes to the treatment of haemophilia, and its application has been approved for haemophilia A and B. The main limitations of gene therapy are currently patients with liver diseases, children, and patients with antibodies to factor[23]. The high price of these preparations is certainly a limiting factor, even though they are given in a single dose only. However, it is believed that preparations that do not contain coagulation factors, i.e., monoclonal antibodies, such as emicizumab, marstacimab, and concizumab, will revolutionize the treatment of haemophilia. They mimic the function of the activated coagulation factor molecule (but do not structurally or immunologically resemble them, therefore the inhibitors have no effect) or inhibit natural endogenous anticoagulants (inhibitors of activation of the extrinsic pathway of coagulation—TFPI). They are regarded as safe to use, have a half-life of up to 4 to 5 weeks, and significantly reduce bleeding rates. Of all these monoclonal antibodies, emicizumab has been studied most and so far has shown the best results[24,25]. Consequently, it is currently the only one approved for clinical use in the largest number of countries. In our country, its use is approved in patients with a severe form of haemophilia A and patients with inhibitors, whereas marstacimab, which is in the final phase of clinical trials, is used in the prophylaxis of bleeding in patients with a severe or moderate form of haemophilia A or B, with or without inhibitors. These preparations are not used in the treatment of acute bleeding, and in case of tooth extraction or oral surgical interventions, pre- and postoperative application of concentrated coagulation factors is required.

U slučaju ekstrakcije zuba ili oralnohirurških intervencija potrebna je preoperativna i postoperativna primena koncentrovanih faktora koagulacije. U fazi kliničkih ispitivanja je i preparat fitusiran (siRNA), koji deluje na antitrombin, a koristi se i u profilaksi krvarenja kod pojedinaca sa teškom ili umerenom formom hemofilije A ili B, sa inhibitorima ili bez njih.

Stomatološki tretman pacijenata sa hemofilijom

Tretman osoba sa hemofilijom smatra se jednim od najrizičnijih u svakodnevnoj stomatološkoj praksi. Stoga, veoma je važno da stomatolog dobro poznaje prirodu oboljenja, simptome i težinu kliničke slike hemofilije. Takođe, potrebno je znati koju terapiju pacijent uzima za lečenje hemofilije, kako i kada je uzima, da li je kod pacijenta dijagnostikovano prisustvo inhibitora faktora koagulacije, kao i da li pacijent ima pridružene bolesti; pritom, posebna pažnja obraća se na moguće infektivne bolesti (naročito na HIV i hepatitis C). Da bi se kod pacijenata sa hemofilijom postigla uspešna stomatološka sanacija, osim detaljne anamneze, koja stomatologu pruža sve potrebne informacije, neophodna je dobra i konstantna saradnja stomatologa i hematologa zaduženog za lečenje osnovnog oboljenja. Uvek su za izvođenje stomatološkog tretmana potrebni dogovor sa hematologom i njegova pisana saglasnost. Takođe, planirana intervencija mora se izvesti u tačno zakazano vreme, onda kada su vrednosti faktora unetih u organizam (krv) bolesnika najveće, odnosno jedan sat nakon primene faktora. Preporuka je da se, zbog odgovarajuće laboratorijske i hematološke podrške, intervencije izvode na početku radne nedelje, ali i ranije u toku dana.

Danas postoje vodiči za stomatološki tretman obolelih od hemofilije u kojima se pre svega ističe značaj prevencije oralnih oboljenja kao imperativa stomatološke struke, posebno kod teških oblika hemofilija i kod pacijenata sa inhibitorima anti-hemofiličnog faktora[26]. Sve to proizilazi iz činjenice da najčešća oralna oboljenja (karijes, gingivitis i parodontopatije) i njihova terapija mogu izazvati ozbiljna krvarenja, koja ponekad mogu ugroziti i život pacijenta.

Sa ciljem prevencije oralnih oboljenja ističe se značaj redovne i pravilne oralne higijene atraumatskim tehnikama. Preporuka je koristiti Basovu tehniku, za čije se izvođenje predlaže upotreba *ultrasoft* četkica za zube[26].

Fitusiran (siRNA), a preparation which has an effect on antithrombin, is also undergoing clinical trials, and is used in the prophylaxis of bleeding in patients with severe or moderate forms of haemophilia A or B, with or without inhibitors.

Dental treatment of patients with haemophilia

Treatment of patients with haemophilia is considered one of the riskiest in everyday dental practice. That is why it is essential that the dentist is acquainted with the nature of the disease, the symptoms, and the severity of the clinical picture. Furthermore, the dentist needs to know what kind of therapy the patient receives for the treatment of haemophilia, whether the patient has been diagnosed with inhibitors to the coagulation factor, and whether the patient has concomitant diseases with special reference to possible infectious diseases (especially HIV and hepatitis C). Apart from a thorough anamnesis that gives the dentist insight into all the mentioned information, success in the dental rehabilitation of patients with haemophilia unquestionably requires good and constant cooperation between the dentist and the haematologist in charge of treating the underlying disease. Prior agreement and written consent of the haematologist is always required for performing dental treatment. In addition, the planned intervention must be performed at the exact scheduled time, when the values of the factors introduced into the patient's body (blood) are highest, i.e., one hour after the administration of factors. Interventions are recommended to be performed at the beginning of the working week, as well as earlier in the day, due to appropriate laboratory and haematological support.

Nowadays, guidebooks for the dental treatment of haemophiliacs are available, primarily emphasizing the importance of preventing oral diseases as an imperative for dentists, especially in severe forms of haemophilia and in patients with antihemophilic factor inhibitors[26]. All this stems from the fact that leading oral diseases (caries, gingivitis, and periodontal disease) and their therapy can cause serious, sometimes life-threatening bleeding.

To prevent oral diseases, the importance of regular and proper oral hygiene using atraumatic techniques is highlighted. It is recommended to use the Bass technique, which implies the recommended use of ultrasoft toothbrushes[26].

U vodičima su navedene oralne intervencije koje ne zahtevaju pripremu pacijenta faktorima koagulacije; to se prvenstveno odnosi na uklanjanje mekih zubnih naslaga i kamenca (ali se ovo ne odnosi na ulanjanje kamenca upotrebom skalera). Pominju se još i ortodontski tretman mobilnim i fiksnim aparatima (uz obavezan oprez zbog mogućih mehaničkih povreda) i protetička rehabilitacija pacijenta mobilnim nadoknadama. U procedurama restauracije treba koristiti koferdam i biti pažljiv pri radu sa matricama, kočićima, sisaljkama i pri grubom uklanjanju vaterolni. Oprez je potreban i prilikom izrade intraoralnog rentgen snimka. Treba biti obazriv i tokom endodontskih tretmana. Pri obradi korenskog kanala poželjni su pažljiva instrumentacija i punjenje kanala do apeksa. Ako dođe do krvarenja, kanal treba ispirati natrijum-hipohloritom, a zatim ga napuniti preparatima na bazi kalcijum-hidroksida ($Ca(OH)_2$). Veruje se da su prilično bezbedne tehnike lokalne anestezije bukalna infiltracija, intraligamentna (intraperiodontalna) i intrapapilarna tehnika. Za sprovodne tehnike i lingvalnu infiltraciju neophodno je pak da hematolog pripremi pacijenta. Savetuje se da se prilikom izvođenja svih tehnika lokalne anestezije koriste što tanje, tj. atraumatske igle.

Oralnohirurški tretman pacijenata sa hemofilijom

Budući da su invazivne, hirurške procedure predstavljaju poseban rizik kod pacijenata sa hemofilijom. Rizičnim se smatraju sve oralnohirurške intrevencije. To važi i za parodontalnu hirurgiju, koja predstavlja visokorizičnu intervenciju. Naime, smatra se da u njoj postoji veći rizik i od ekstrakcije zuba i da je treba izbegavati što je više moguće. Indikovana je jedino ako konzervativne mere nisu imale uspeha i ako je oralna higijena pacijenta dobra.

Uprkos tome što sa sobom nose veliki rizik, oralnohirurške intervencije mogu se izvoditi prilično bezbedno. Međutim, za to su potrebni adekvatna laboratorijska podrška (krvna slika i skrining koagulacije), pažljivo preoperativno planiranje, odgovarajuća hemostaza sa dovoljnom količinom faktora koagulacije i drugih produkata, te adekvatan postoperativni tretman.

U preoperativnom periodu treba ukloniti meke i čvrste naslage sa zuba, i to sa dezinfekcijom usne duplje preparatima na bazi hloheksidina. Pre operacije obavezno treba odrediti nivo faktora i moguće prisustvo inhibitora.

Guidebooks highlight oral interventions that do not require the preparation of the patient with coagulation factors, primarily referring to the removal of soft dental deposits and calculus (excluding the use of scalers), orthodontic treatment with mobile and fixed appliances (with special caution to possible mechanical injuries), and prosthetic rehabilitation of the patient using removable restorations. During restorative procedures, the use of rubber dams is required, with great caution when working with matrices, dental posts, suction cups and rough removal of cotton rolls. Caution is also required when making an intraoral RO image. Endodontic treatment also requires great caution. During root canal treatment, careful instrumentation and filling of the canal up to the apex is desirable. In case of bleeding, the canal should be rinsed with Na-hypochlorite, and then filled with preparations based on $Ca(OH)_2$. Regarding local anaesthesia techniques, buccal infiltration, intraligamentary (intraperiodontal), and intrapapillary techniques are considered safe, whereas nerve-block techniques and lingual infiltration require mandatory preparation of the patient by a haematologist. It is recommended to use ultra-thin atraumatic needles for all local anaesthesia techniques.

Oral surgical treatment of patients with haemophilia

Surgical procedures are invasive and pose a particular risk to patients with haemophilia. All oral surgical interventions are considered risky, including periodontal surgery, which is a high-risk intervention. It is considered that it can pose a greater risk than tooth extraction and should be avoided as much as possible. It is only indicated when conservative measures have failed and in the presence of good oral hygiene.

Despite the high risk, oral surgical interventions can be performed quite safely, but this requires adequate laboratory support (blood count and coagulation screening), careful preoperative planning, appropriate haemostasis with enough coagulation factors and other products, as well as adequate postoperative care.

During the preoperative period, it is necessary to remove soft and hard deposits from the teeth and disinfect the oral cavity with chlorhexidine-based preparations. Prior to surgery, it is necessary to determine the level of factors and possible presence of inhibitors. Haematological preparation of the patient for the procedure is obligatory and is carried out together with a haematologist.

Hematološka priprema pacijenta za intervenciju obavezna je i sprovodi se u konsultaciji sa hematologom. Preporučena doza pre ekstrakcije zuba kod hemofilije A iznosi 50 IU/kg FVIII, a kod hemofilije B 100 IU/kg F IX. Preovladava stav da nivo faktora pre ekstrakcije zuba treba da bude najmanje 50%, odnosno od 75% do 100% pre ozbiljnijih hirurških zahvata. Posebno su rizične intervencije kod pacijenata sa razvijenim inhibitorima. Kod ovih pacijenata se i u hematološkoj pripremi i postoperativno uglavnom koriste aktivisani rekombinantni F VII ili FEIBA (engl. *Factor Eight Inhibitor Bypassing Activity*), kao i aktivisani koncentrovani protrombinski kompleks (eng. *activated prothrombin complex concentrate*-aPCC). Takođe, poželjno je da se pre većih hirurških intervencija razmotri sistemska preoperativna primena antifibrinolitika u danu pre hirurške intervencije (TXA 1 g/8 h ili EACA 50 mg/kg / 6 h), a zatim sa njom nastavi narednih dana (pacijent ovu terapiju prima ukupno sedam dana)[27].

Stomatološka hirurška intervencija trebalo bi da bude pažljivo i temeljno isplanirana i sprovedena tako da trauma tkiva bude što manja. Ako postoji indikacija da se izvadi veći broj zuba, preporučuje se da se izvede višestruka ekstrakcija zuba odjednom, zbog toga što češće davanje derivata krvi transfuzijom može usloviti pojavu inhibitora u krvi bolesnika. Posle pažljive obrade ekstrakcione rane, preporučuje se da se od lokalnih hemostatičkih sredstava upotrebe oksidisana celuloza (*Surgicel*®), hemofibrin, preparati na bazi kolagena, želatinski preparati, *TachoSil*® (humani fibrinogen i trombin na kolagenskom flasteru), kao i fibrinski lepak (*Beriplast*®, *Tissucol*®). Postoje i podaci o tome da se *Ethisorb*® koristi u oralnohirurškim intervencijama (apsorptivni poliglaktin, polidioksanon)[28]. Postavljanje sutura treba sprovesti pažljivo i sa minimalnom traumom tkiva, vodeći pritom računa o izboru šavnog materijala; preporučuje se primena silka ili resorptivnog šavnog materijala. U slučaju ekstrakcije većeg broja zuba treba razmotriti primenu mekog splinta u trajanju od najmanje 48 sati.

Postoperativnom oporavku treba posvetiti veliku pažnju zbog mogućih komplikacija, pa je potrebna svakodnevna kontrola pacijenata. Pacijentu treba dati precizna uputstva kako da se ponaša u postoperativnom periodu (ne treba da ispira usta naredna 24 sata, treba da jede meku hranu, ne treba da puši, ne treba da se napreže).

The recommended dose before tooth extraction in haemophilia A is 50 IU/kg FVIII, i.e., 100 IU/kg FIX in haemophilia B. It is generally considered that the factor level before tooth extraction should be at least 50%, i.e. 75–100% before major surgical procedures. Interventions in patients with developed inhibitors are particularly risky. In these patients, activated recombinant FVII, or FEIBA (Factor Eight Inhibitor Bypassing Activity), as well as activated concentrated prothrombin complex (aPCC), are mainly used both in the haematological preparation and postoperatively.

In addition, it is desirable to consider the systemic preoperative administration of antifibrinolytics one day before major surgical interventions (TXA 1 g/8 h or EACA 50 mg/kg/6 h) and then continue the therapy for the following 7 days[27].

Dental surgical interventions should be carefully and thoroughly planned and performed with as little tissue trauma as possible. If there is an indication for multiple tooth extraction, it is recommended to proceed with tooth extraction in one act, given that frequent administration of blood derivatives via transfusion may lead to the appearance of inhibitors in the patient's blood. After the wound has been carefully treated, it is recommended to use oxidized cellulose (Surgicel®), hemofibrin, collagen-based preparations, gelatine preparations, TachoSil® (human fibrinogen and thrombin on a collagen patch) and fibrin glue (Beriplast®, Tissucol®) as local haemostatic agents. The use of Ethisorb® in oral surgical interventions (absorbable polyglactin/polydioxanone) has also been described[28]. Suture placement should be carried out carefully with minimal tissue trauma, paying special attention to the choice of suture material—the use of silk or resorbable suture material is recommended. In the case of multiple tooth extraction, the application of a soft splint for at least 48 hours should be considered.

Postoperative recovery should be given great attention due to possible complications. Therefore, daily monitoring of patients is required. The patient should be given precise instructions on how to behave in the postoperative period (24 hours without rinsing the mouth, soft diet, no smoking, no stress). Bleeding can even be expected on the 4th day after the intervention due to the presence of fibrinolysis activators in saliva, which enable the conversion of plasminogen into active plasmin thus causing pathological fibrinolysis. Hence, it is necessary to use local fibrinolytics to prevent this reaction after oral surgical interventions.

Kod njih se i četiri dana nakon intervencije može očekivati krvarenje nastalo usled prisustva aktivatora fibrinolize u pljuvački; oni omogućavaju pretvaranje plazminogena u aktivni plazmin, što prouzrokuje patološku fibrinolizu. Upravo zato, nakon oralnohirurških intervencija treba koristiti lokalne fibrinolitike koji sprečavaju ovu reakciju. U te svrhe predlaže se da se koriste Capramol, Cyklokapron, Antagosan, PAMBA, u kombinaciji sa sorbacel gazom. Osim toga, utvrđeno je da lokalna primena TXA značajno smanjuje postoperativno krvarenje. TXA je desetak puta efikasnija od aminokapronske kiseline.

Predlaže se dvominutno ispiranje usta sa 10 ml 5% rastvora po četiri puta dnevno narednih sedam dana ili lokalna aplikacija tupfera natopljenih antifibrinolitikom na ekstrakcionu ranu; to se može kombinovati i sa terapijom tabletama u narednih pet dana. Kada je reč o primeni koncentrovanih faktora koagulacije u postoperativnom periodu, *World Federation of Hemophilia* (WFH) preporučuje da se supstituciona terapija primenjuje najmanje tri dana kod manjih i najmanje od sedam do deset dana kod većih hirurških intervencija.

Indikovana je i antibiotska i analgetska terapija, a po potrebi i terapija anksioliticima. Intramuskularnu aplikaciju medikamenata i primenu nesteroidnih antiinflamatornih lekova treba izbegavati. Kada su posredi analgetici, dozvoljava se upotreba paracetamola, paracetamola sa kodeinom, paracetamola sa tramadolom, kao i COX-2 inhibitora.

Zaključak

Iako se tretman osoba sa hemofilijom smatra jednim od najrizičnijih u svakodnevnoj stomatološkoj praksi, može biti uspešno i bezbedno realizovan. Međutim, veoma je važno da stomatolog dobro poznaje prirodu oboljenja, simptome i težinu kliničke slike hemofilije. Takođe, treba znati koju terapiju za lečenje hemofilije pacijent uzima, kako i kada je uzima, da li je kod pacijenta dijagnostikovano prisustvo inhibitora faktora koagulacije, te da li pacijent ima pridružene bolesti (posebna pažnja obraća se na moguće infektivne bolesti). Osim svega navedenog, za uspešnu i bezbednu intervenciju kod pacijenata sa hemofilijom potreban je dobro isplaniran preoperativni, perioperativni i postoperativni tretman.

For this purpose, the use of capramol, cyklokapron, Antagosan, and PAMBA in combination with SorbaCt gauze is recommended. Furthermore, topical application of TXA was found to significantly reduce postoperative bleeding. TXA is approximately 10 times more effective than aminocaproic acid.

It is recommended to rinse the mouth with 10 ml of 5% solution for 2 minutes 4 times a day for the next 7 days, or to apply swabs soaked in antifibrinolytic to the extraction wound, combined with tablet therapy for the next 5 days. Regarding the use of concentrated coagulation factors in the postoperative period, the World Federation of Haemophilia (WFH) recommends the use of substitution therapy for at least 3 days for minor and at least 7–10 days for major surgical interventions.

Antibiotic and analgesic therapies are indicated, as well as anxiolytic therapy if necessary. Intramuscular administration of medication should be avoided, as should the use of non-steroidal anti-inflammatory drugs. Analgesics such as paracetamol, paracetamol with codeine, paracetamol with tramadol, and COX-2 inhibitors are permitted.

Conclusion

The treatment of patients with haemophilia is considered one of the riskiest in everyday dental practice. Despite this, dental interventions can be successfully and safely performed. However, the dentist must be well-acquainted with the nature of the disease, its symptoms and the severity of the clinical picture. Furthermore, the dentist is obliged to know what kind of therapy the patient receives for the treatment of haemophilia, whether the patient has been diagnosed with inhibitors to the coagulation factor, and whether the patient has concomitant diseases with special reference to possible infectious diseases. In addition, the key to a successful and safe intervention lies in a well-planned pre operative, perioperative and postoperative treatment of patients with haemophilia.

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UPUTSTVA AUTORIMA

Acta Stomatologica Naissi je naučni časopis Klinike za dentalnu medicinu, Medicinskog fakulteta Univerziteta u Nišu, koji publikuje radove iz svih oblasti stomatologije i srodnih medicinskih grana.

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Kada se radi o eksperimentima na humanom materijalu ili pacijentima, ukazati da li je primenjeni postupak u skladu sa etičkim standardima odgovornog komiteta za ljudske eksperimente ili sa Deklaracijom iz Helsinkija (1964, amandmani iz 1975 i 1983) Svetske medicinske asocijacije.

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Radovi treba da budu napisani na A4 formatu sa duplim proredom, obezbeđujući 25 mm margine. Samo jedna kopija rada treba da sadrži prezime i prvo slovo autorovog imena u gornjem desnom uglu. Broj stranica rada počinje sa naslovnom stranom kao strana 1 i nastavlja se saređanjem.

NASLOVNA STRANA

Gornji deo naslovne strane treba da sadrži: a) puni naslov rada (velikim slovima), b) puna imena (prvo ime, srednje slovo ako je primenljivo i poslednje ime) svih autora bez akademskih titula, c) nazivi institucija i d) radni naslov od ne više od 10 reči. Na dnu naslovne strane molimo da ukažete na ime autora odgovornog za korespondenciju, sa akademskim zvanjem, poštanskom adresom, telefonskim i fax brojevima i E-mail adresom.

Sledeća strana počinje samo sa naslovom, i dalje se nastavlja sa tekstom. Tekst treba da bude podeljen u delove sa naslovima: uvod, pacijenti/materijal i metod rada, rezultati, diskusija, zaključci, zahvalnost i literatura. Za tabele, figure (slike) i legende vidi deo Tabele i Figure.

Poželjno je da se koriste reči prikladne za indeksiranje i pretraživanje. Ako takvih reči nema u naslovu, poželjno je da se naslovu doda podnaslov.

Ako je članak u prethodnoj verziji bio izložen na skupu u vidu usmenog saopštenja (pod istim ili sličnim naslovom) podatak o tome treba da bude naveden u posebnoj napomeni pri dnu prve strane članka.

APSTRAKT I KLJUČNE REČI

Originalni radovi moraju da sadrže strukturni apstrakt od 250 reči, podeljenih na sledeća 4 paragrafa:

Uvod: opisuje problem o kome se radi u radu

Materijali i metode: opisuje kako je istraživanje sprovedeno

Rezultati: opisuje primarno rezultate

Zaključak(ci): saopštenje autora o zaključcima proisteklim iz rezultata, i implicira njihovu kliničku primenljivost.

Strukturni apstrakti nisu potrebni kod uvodnika i pisma. Ispod apstrakta stoje ključne reci i to tri do pet. Ključne reči mogu biti uzete samo iz Medical Subjects Headings (MeSH).

Apstrakt treba da bude preveden i na engleski jezik (US style), sa naslovom, imenima autora, institucija i ključnim recima.

Za pisanje radova u formi prikaza slučaja, treba uraditi strukturirani apstrakt, na sledeći način:

Osnova problema: (opisati problem ili pojavu u nekoliko rečenica),

Metode rada: (opisati kako je obrađen i dijagnostikovan pacijent i koja bolest ili poremećaj je u pitanju),

Rezultati: (opisati rezultate rada i krajnji ishod),

Zaključak: (1-3 rečenice koja može da služi i kao opis celog postupka koji je rađen i napisan u radu).

TABELE I FIGURE

Svaka tabela sa jasnim naslovom na srpskom i engleskom treba da bude otkucana sa duplim proredom na odvojenom papiru. Obeležiti brojevima tabele jednu za drugom kako nailaze posle prvog navođenja u tekstu (obeležavaju se arapskim brojevima). Dati svakoj kolumni kratko ili skraćeno zaglavlje. Staviti objašnjenja u legendama svih nestandardnih skraćenica korišćenih u tabeli. Za jedinice i merenja vidi odeljak niže. Ne koristiti unutrašnje horizontalne i vertikalne linije. Staviti sve tabele na kraju vaseg fajla. Uvek odvojiti posebne kolumne upotrebom tabulatora, a ne upotrebom razmaknice, tabele moraju biti u tekst formatu.

Linijski prikazani dijagrami i ilustracije (fotografije, fotomikrografije itd.), trebaju biti osmišljene kao figure. Oni takođe treba da budu smešteni na odvojenom listu papira i numerisani jedan za drugim arapskim brojevima u saglasnosti sa prvim koji je citiran u tekstu. Figure treba da budu profesionalno nacrtane i fotografisane. Svaka figura treba da bude etiketirana pozadi ukazujući broj figure, prezime i prvo slovo imena autora, i vrh figure. Fotografije treba da se daju u dva primerka. Kolor fotografije ce se štampati samo u dogovoru sa urednikom ili ako autor sam snosi troškove. Fotomikrografije moraju imati obeleženu unutrasnju razmeru, i simbole, i strelice ili slova treba da su u kontrastu sa pozadinom. Na fotografijama pacijenata mora se sakriti identitet, osim ako se pacijenti u pismenoj formi slože sa objavljivanjem njihovih fotografija sa identitetom. Ukoliko ste pozajmili ili već publikovali negde fotografije priložite i pismenu dozvolu za reprodukovanje. Naslovi i detaljna objašnjenja fotografija treba da budu data u legendama. Ako su korišćeni simboli, strelice, brojevi ili slova za identifikaciju delova slike objasniti svaku jasno u legendi.

ZAHVALNOSTI

Priznanja i zahvalnosti prethode literaturi specificirajući generalnu podršku kao i odeljenje i ime šefa odeljenja, priznanja tehničkoj pomoći i konačno finansijskoj i materijalnoj pomoći. Navesti naziv i broj projekta, odnosno naziv programa u okviru koga je nastao članak i naziv institucije koja je finansirala projekat, u posebnoj napomeni pri dnu prve strane članka.

LITERATURA

Autori su odgovorni za tačnost literaturnih podataka. Reference treba da budu na posebnom listu i delu odmah iza teksta. Samo reference bitne za studiju mogu biti citirane. Kada je citiranje literature neophodno primeniti Vankuver stil. Na posebnom listu se navode citati referenci koji su označeni rednim brojevima po redosledu u kome se pojavljuju u tekstu i svaki citat odgovara brojevima koji sadrži navedenu referencu. Primeri tačnih oblika referenci :

RADOVI U ČASOPISIMA

1. Standardni članak u časopisu (lista svih autora, ali ako je broj veći od šest citirati tri i dodati et al): Glass DA, Mellonig JT, Towle HJ. Histologic evaluation of bone inductive proteins complexed with coralline hydroxyapatite in an extraskeletal site of the rat. J Periodontol 1989; 60:121-125.

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JEDINICE MERE

Sva merenja treba da budu izražena u terminima Internacionalnog Sistema Jedinica (Si).

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Klinika za Stomatologiju

Bul. Zorana Đinđića 52

18000 Niš, Srbija

E-mail: tarana.simona@gmail.com, tijanicm@yahoo.com

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The title page should contain: a) the full title of the article (in upper case); b) first name, middle initial, and last name of each author without the academic degree; c) name of department and institutional affiliation for each author; d) running title of no more than 10 characters. At the bottom of the page, please indicate the name, academic degree and address (including E-mail, telephone and fax number) of the author responsible for correspondence.

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Results: (describe the results of the work and the final outcome),

Conclusion: (1-3 sentences that can also serve as a description of the whole procedure that was done and written in the paper).

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Basis of the problem: (describe the problem or occurrence in a few sentences),

Methods of work: (describe how the patient was treated and diagnosed and which disease or disorder is in question),

Results: (describe the results of the work and the final outcome),

Conclusion: (1-3 sentences that can also serve as a description of the whole procedure that was done and written in the paper).

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ACKNOWLEDGEMENTS

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Journals:

1. Standard journal reference. (Note: list all authors if six or less; when seven or more, list only first three and add et al): Glass DA, Mellonig JT, Towle HJ. Histologic evaluation of bone inductive proteins complexed with coralline hydroxyapatite in an extraskeletal site of the rat. J Periodontol 1989;60:121-125.

2. Corporate author: Federation Dentaire Internationale. Technical Report No.28. Guidelines for antibiotic prophylaxis of infective endocarditis for dental patients with cardiovascular disease. Int Dent J 1987;37:235.

3. No author given: Coffee drinking and cancer of the pancreas (editorial). BMJ 1981;283:628.

4. Volume with supplement: Magni R, Rossoni G, Berti R, BN52021 protect guinea pig from heart anaphylaxis. Pharmacol Res Commun 1988; 20 Suppl 5:75-8.

Books or other monographs:

5. Personal author(s): Tullman JJ, Redding SW. Systemic Disease in Dental Treatment. St. Louis: The CV Mosby Company; 1983:1-5.

6. Chapter in a book: Rees TD. Dental management of the medically compromised patient. In: McDonald RE, Hurt WC, Gilmore HW, Middleton RA, eds. Current Therapy in Dentistry, vol. 7. St. Louis: The CV Mosby Company; 1980:3-7.

7. Dissertations and thesis: Teerakapong A. Langerhans Cells in human periodontally healthy and diseased gingiva. (Thesis). Houston, TX: University of Texas; 1987.92 p.

Other published material:

8. Newspaper article: Shaffer RA.Advances in chemistry are starting to unlock mysteries ofthe brain. The Washington Post 1989Ang 7; Sect.A:2 (col. 5).

References - electronic quotations:

9. Online journals without volume and page information. Berlin JA, Antman EM. Advantages and limitations of metaanalytic regressions of clinical trials data. Online J Curr Clin Trials (serial online). June 4; doc 134. Accessed July 20, 2000.

10. Online journals with volume and page information. Fowler EB, Breault LG. Ridge augmentation with a folded acellular dermal matrix allograft: A case Report. J Contemp Dent Pract (serial online). 2001;2(3):31-40. Available from: Procter&Gamble Company, Cincinnat, OH. Accessed December 15, 2001.

11. World Wide Web.Centers for Disease Control and Prevention. Preventing emerging infectious diseases: Addressing the problem of antimicrobial resistance. Available at: http://www.cdc.gov/ncidod/emergplan/antiresist/. Accessed November 5, 2001.

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Secretaries: Ass. Simona Stojanović, Mr. Sci Dr Milos Tijanić

Clinic of Dental Medicine Bul. Zorana Djindjića 52

18000 Niš, Serbia

E-mail: tarana.simona@gmail.com , tijanicm@yahoo.com

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