NAUČNI RAD
SCIENTIFIC ARTICLE

ZNAČAJ KVAŠLJIVOSTI ZA RETENCIJU TOTALNIH ZUBNIH PROTEZA

THE IMPORTANCE OF WETTABILITY FOR RETENTION OF FULL DENTURES

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Kratak sadržaj

U smislu poboljšanja kvašljivosti polymethyl metacrilat-a (PMMA) i povećanja biofizičke komponente ukupnog retencionog potencijala totalne zubne proteze (TZP), u literaturi je opisan niz pokušaja povećanja specifične površinske energije.
Cilj rada je procena kvašljivosti eksperimentalnih pločica (EP) od PMMA u zavisnosti od njihovog površinskog tretmana i površinskog napona (PN) aplicirane eksperimentalne tečnosti (ET).
Procena kvašljivosti EP je obavljena uz primenu posebne merne opreme a preko serije premeravanja dijametra kapi formiranih nakapavanjem, pod identičnim uslovima, na površine datih.
U našim eksperimentima, optimalni vremenski interval peskiranja je 40 s za sve EP koje su podvrgnute ovom obliku mehaničke izmene površinske strukture, čime se utiče, posredno, i na promenu nivoa površinske energije akrilata.
Veći stepen kvašljivosti metaliziranih EP se tumači povećanjem njihove površinske energije na graničnoj površini okolni vazduh-čvrsto telo. U slučaju mekih akrilata, izgleda da postoji njihov veći afinitet u odnosu na molekule adheziva čime se postiže bolje kvašenje.

Ključne reči: *retencija, adhezija, totalna zubna proteza, kvašljivost*

Abstract

In the sense of betterment of wettability of polymethyl metacrylat (PMA) and enlargement of biophysical component of total retention potential of full denture (FD), there is in literature described quite a number of trials to enlarge specific surface energy.
The aim of the paper is estimation of wettability of experimental plates (EP) of PMA depending on their surface treatment and surface voltage (SV) of applied experimental fluid (EF).
Estimation of wettability of EP was performed with application of particular measuring equipment and through series of measuring diameters of drops formed by pouring out, under identical conditions, on surfaces of given ones.
In our experiments, optimum time interval of sand blasting is 40 s for all EP subjected to this form of mechanical change of surface structure by which there is intermediary influence too on change of level of acrylat surface energy.
Higher degree of wettability of metallized EP is explained due to enlargement of their surface energy on border surface surrounding air -solid body. In the case of soft acrylats, there seems to exist their bigger affinity in relation to molecules of adhesive by which better wetting is achieved.

Key words: *retention, adhesion, full denture, wettability*

Uvod

Analizom literaturnih podataka koji se odnose na biofizičke faktore retencije TZP, može se konstatovati nekoherentnost laboratorijskih i kliničkih nalaza, pojedinih autora, po pitanju svih problema koji se odnose na ovaj aspekt TZP, izuzimajući kvašljivost gradivnih proteznih materijala.[1–6]

Od samog početka primene polymethyl metacrilat-a (PMA) u stomatološkoj praksi, uočena

Introduction

By analyzing literature data concerning biophysical factors of FD retention, there may be stated incoherence of laboratory and clinical findings of certain authors as concerns all problems relating to this aspect of FD except for wettability of composite denture materials.[1–6]

From the very beginning of application of polymethyl metacrylat (PMA) in the practice of stomatology, there is noted its weaker wetje njegova slabija kvašljivost tečnostima što se tumači niskom specifičnom površinskom energijom ovog materijala (40 x 10 -3N/m).[5-9]

U cilju poboljšanja kvašljivosti PMMA, što se verifikuje smanjenjem kontaktnog ugla na graničnoj površini tečnost-vazduh, preduzeta je čitava serija pokušaja za povećanje njegove površinske energije: deponovanjem silikon-tetrahlorida, korišćenjem posebnih hidrofilnih PMMA, deponovanjem raznih hidrofilnih radikala, postupkom metaliziranja PMMA, i drugo.[2–7]

Pokušavalo se i sa mehaničkom izmenom površinske strukture postupcima njegovog nahrapavljenja.

Cilj rada

Cilj rada je procena kvašljivosti eksperimentalnih pločica (EP) od PMMA, u zavisnosti od njihovog površinskog tretmana i površinskog napona (PN) aplicirane eksperimentalne tečnosti (ET).

Materijal i metode

Procena kvašljivosti EP obavljena je preko serije premeravanja dijametra kapi koje su formirane nakapavanjem, pod identičnim uslovima, na površine datih EP.

Postojale su sledeće serije EP:

- od toplopolimerizovanog PMMA koji je poliran, pri čemu je druga polovina pločice peskirana, kod jednih grupa 20 s, drugih 40 s i trećih 60 s.

- od toplopolimerizovanog PMMA koji je obložen slojem legure paladijuma (300-350 nm), tehnikom vakuumskog naparivanja i koji nije peskiran.

- toplopolimerizovan akrilat obložen slojem mekog akrilata (Coe comfor tissu conditioner).

- od autopolimerizovanog akrilata (Simigal®-K), jedna polovina EP je polirana, a druga peskirana u navedenim vremenskim intervalima.

- od korektivnog autopolimerizovanog akrilata (Koo Liner®), jedna polovina EP je polirana, a druga, kao u prethodnoj seriji, peskirana.

Mikrohrapavost površina je kontrolisana mikrografom (profilometrom) tipa Homel Tester T 20 DS firme „Homelwerke“ - Z. Nemačka, sa

tability by fluids which is explained with low specific surface energy of this material (40 x lCT3N/m).[5-9]

Aiming to improve wettability of PMA, which is verified by reducing contact angle on border surface fluid-air, there was undertaken a whole series of trials to enlarge its surface energy: by depositing silicon-tetrachloride by using separate hydrophilus PMA, by depositing various hydrophilous radicals, by procedure of metallizing PMA and other.[2–7]

There were attempts also with mechanical change of surface structure by procedures of its roughening.

Aim of paper

Aim of paper is estimation of experimental plates (EP) wettability from PMA depending on their surface treatment and surface voltage (SV) of applied experimental fluid (EF).

Material and methods

Estimation of wettability of EP was performed through series of measuring diameter of drops which are formed by pouring out, under identical conditions on surfaces of given EP.

There existed the following series of EP:

- from warmpolymerized PMA which is polished whereupon the other half of the plate is sand blasted, with certain groups 20 s, others 40 s and third 60.

- from warmpolymerized PMA which is coated by layer of alloy of paladium (300-350 nm), by technique of vacuum steaming and which is not sand blasted.

- from warmpolymerized acrylat coated with layer of soft acrylat (Coe comfort tissue conditioner).

- from autpolymerized acrylat (Simigalr-K) one half of EP is polished and the other is sand blasted in stated time intervals.

- from corrective autopolymerized acrylat (Koo Liner®), one half of EP is polished and the other, like in preceding series, sand blasted.

Microroughness of surfaces is controlled by micrograph (proflometer) type Homel Tester T 20 DS firm „Homelwerke“ - W. Germany, with possibility of computer analysis of obtained profilometric curves.

mogućnošću kompjuterske analize dobijenih profilometrijskih krivulja.

Kao ET korišćene su: pljuvačka PN graničnoj površini sa svojom parom od 53.2 x 10 -3N/m i dinamičkog viskoziteta 3,6l mPa x s, voda (72,58 x 10 -3N/m, 1.005 mPa x s i rastvor glicerola u koncentraciji koja ima PN od 66,00 x 10-3N/m i dinamički viskozitet 6.05 mPa x s (sve vrednosti dobijene merenjem: Tenziometar Kruss T-52, rotacioni viskozimetar Haake RV-12 sa senzorom NV).

Pri ovome su prisutne i manje razlike u specifičnoj težini navedenih ET, koje se zanemaruju u datom eksperimentu (1,002-1,017 za pljuvačku, 0,99867 za vodu i 1,1269 gr/cm^3 za glicerin).

Nakapavana je uvek jednaka zapremina ET, sa visine od 7 mm pomoću mikropipete podešavajućeg kapaciteta od 10-30 µl, tip Albsoluter, koja je fiksirana na datu visinu pomoću odgovarajućeg stalka.

Premeravanja dijametra kapi, pod upravnim uglom u odnosu na kontaktnu površinu ET-EP, je obavljeno pomoću binokularne lupe MBS-2 sa uvećanjem 7,5 puta, gde su izvršene određene konstrukcione izmene. U okular je ugrađena merna rešetka, pri čemu, za dato uvećanje, podeok na skali odgovara 0,08 mm.

Za svaku ET, i datu eksperimentalnu poziciju, premereno je po 30 kapi. Na bazi dobijenih merenja, izračunate su prosečne vrednosti.

Prvobitno čišćenje i odmašćivanje EP obavljeno je u kadama sa dejonizovanom vodom uz primenu ultrazvuka, a kasnije i hemijski.

Rezultati i diskusija

Rezultat procene kvašljivosti EP prezentirani su na tabelama 1,2,3.

Analizom tabele 1, zapažaju se, u slučaju polirane polovine EP od toplopolimerizovanog PMMA; najveće prosečne vrednosti dijametra kapi pljuvačke i nešto manje kod preostale dve ET.

Peskirane polovine istih pločica dovode do većeg „rasplinjavanja“ ET u odnosu na prethodno stanje površine. Pri ovome, najveće vrednosti dijametra kapi, za sve ET, registrovane su posle perioda peskiranja EP od 40 s. Interval peskiranja od 60 sek. uslovio je nešto manje prosečne vrednosti analiziranog obeležja, u odnosu na prethodni, ali ipak veći od početnog intervala (20 s).

With EF there were used: saliva SV on border surface with its steam of 53.2 x 10-3N/m and dynamic viscosity 3.61 mPa x s, water (72.58 x 10 3 N/m, 1.005 mPa x s and dilution of glycerol in concentration which has SV of 66.00 x 10~3N/m and dynamic viscosity 6.05 mPa x s (all values obtained by measurement: Tensiometer Kruss T-52, rotation viscosimeter Haake RV-12 with sensor NV).

With this there are also present minor differences in specific weight of mentioned EF which are neglected in given experiment (1.002-1.017 for saliva, 0.99867 for water and 1.1269 gr/cm^3 for glycerine).

There was poured out always equal volume of EF from height of 7 mm by way of micropipette of adjustable capacity of 10-30 µl, type Absoluter, which is fixed to given height by way of corresponding stand.

Measurements of diameter of drops, under right angle in relation to contact surface EF-EP, are performed by way of binocular magnifier MBS-2 with magnification of 7.5 times where there were performed certain construction changes. A measuring grate is built in ocular whereby, with given enlargement, partition on scale corresponds to 0.08mm.

For each EF and given experimental position, there were measured 30 drops each. On the basis of obtained measurements, mean values were calculated.

Original cleaning and degreasing of EP was performed in tubs with deionized water with application of ultrasound and later chemically as well.

Results and discussion

Result of estimation of wettability of EP are presented on tables 1, 2, 3.

By analysing table 1, there are observed, in the case of polished half of EP from warm-polymerized PMA, the biggest mean values of diameter of saliva drop and slightly less with remained two EF.

Sand blasted halves of he same plates lead to greater „extention“ of EF in relation to previous state of surface. Thereby, the biggest values of drop diameter, for all EF are registered after period of sand blasting EP of 40 s. Interval of sand blasting of 60 sec conditioned slightly smaller mean values of analyzed feature in relation to the previous however still bigger than beginning interval (20 s).

Tabela 1. Kvašljivost eksperimentalnih pločica ispoljena preko veličine kapi u zavisnosti od površinskog napona tečnosti i površinske strukture pločica

NAZIV MATERIJALA OD KOGA JE IZRAĐENA EKSPERIMENTALNA PLOČICA		PROSEČNE VELIČINE KAPI** (mm)					
		POVRŠINSKA OBRADA PLIČICE					
		POLI-RANJE	PESKARENJE SiO_2*			METALIZI RANJE ***	OBLAGANJE MEKIM AKRILATOM ****
			20’	40’	60’		
TOPLO POLIMERIZIRAN AKRILAT	• PLJU.	3,99	5,05	5,50	5,42		
	GLY.	3,68	3,87	4,53	4,26		
	H_2O	3,49	3,66	3,74	3,70		
TOPLO POLIMERIZIRAN AKRILAT	• PLJU.					5346	
	GLY.					4,70	
	H_2O					4,20	
TOPLO POLIMERIZIRAN AKRILAT	• PLJU.						4,94
	GLY.						4,18
	H_2O						4,01
AUTOPOLI-MERIZIRAN AKRILAT	• PLJU.	3,97	5,10	5,63	5,48		
	GLY.	3,36	3,98	4,48	3,83		
	H_2O	3,22	3,00	3,86	3,76		
KOREKTIVNI AUTOPOLI-MERIZIRAN AKRILAT „KOO LINER®“	• PLJU.	4,24	5,58	5,79	5,81		
	GLY.	4,08	4,42	4,42	4,38		
	H_2O	3,82	4,32	4,28	4,20		

LEGENDA

* UDALJENOST 40 mm; PRITISAK OKO 0,5 N

** PROSEČNA VREDNOST VELIČINE 30 KAPI ZA SVAKU POZICIJU

*** POSTUPKOM VAKUUMSKOG NAPARIVANJA NATALOŽENI SLOJEVI:

PALADORA 300-350 nm

LEGURE C –C –M 150-200 nm

****COE®COMFORT-TISSUE-CONDITIONER

• POVRŠINSKI NAPONI PLJU. - $\overline{X} = 53 \cdot 10^{-3}$ N/m

GLY. - $\overline{X} = 66 \cdot 10^{-3}$ N/m

H_2O - $\overline{X} = 72.5 \cdot 10^{-3}$ N/m

Table 1. Wettability of experimental plates shown through size of drops depending on surface voltage of fluid and surface structure of plates

NAME OF MATERIAL WITH WHICH EXPERIMENTAL PLATE IS MADE		MEAN SIZES OF DROPS** (mm)					
		SURFACE PROCESSING OF PLATES					
		POLI-SHING	SAND BLASTING SiO_2* TIME OF LASTING			METAL IZING ***	COATING WITH SOFT ACRYLAT ****
			20’	40’	60’		
WARM POLYMERIZED ACRYLAT	• SALIVA	3.99	5.05	5.50	5.42		
	GLY.	3.68	3.87	4.53	4.26		
	H_2O	3.49	3.66	3.74	3.70		
WARM POLYMERIZED ACRYLAT	• SALIVA					5346	
	GLY.					4.70	
	H_2O					4.20	
WARM POLYMERIZED ACRYLAT	• SALIVA						4.94
	GLY.						4.18
	H_2O						4.01
AUTOPOLI-MERIZED ACRYLAT	• SALIVA	3.97	5.10	5.63	5.48		
	GLY.	3.36	3.98	4.48	3.83		
	H_2O	3.22	3.00	3.86	3.76		
CORRECTIVE AUTOPOLY-MERIZED ACRYLAT „KOO LINER®“	• SALIVA	4.24	5.58	5.79	5.81		
	GLY.	4.08	4.42	4.42	4.38		
	H_2O	3.82	4.32	4.28	4.20		

INSCRIPTION

* DISTANCE 40 mm< PRESSURE ABOUT 0,5 n

** MEAN VALUE OF SIZE OF 30 DROPS FOR EACH POSITION

***WITH PROCEDURE OF VACUUM STEAMING DEPOSITED LAYERS:

PALADORA 300-350 mm

ALLOYS C –C –M 150-200 nm

**** COE®COMFORT-TISSUE-CONDITIONER

• SURFACE VOLTAGES SALIVA- $\overline{X} = 53 \cdot 10^{-3}$ N/m

GLY. - $\overline{X} = 66 \cdot 10^{-3}$ N/m

H_2O - $\overline{X} = 72.5 \cdot 10^{-3}$ N/m

Tabela 2. Statistički parametri koji karakterišu kvašljivost eksperimentalnih pločica – veličina kapi pljuvačke – (mm)

STATISTIČKI PARAMETRI	UPOREĐIVANJE SERIJE TOPLO POLIMERIZOVANIH AKRILNIH PLOČICA					
	POVRŠINSKI TRETMAN					
	POLIRANJE	PESKIRANJE			METAL-IZIRANJE	MEKI AKRILAT
		20’	40’	60’		
BROJ KAPI μ ( )	30	30	30	30	30	30
$\overline{X}$- VELIČINA KAPI	3,99	5,05	5,50	5,42	5,46	4,94
SD	0,8	0,28	0,37	1,14	0,69	0,65
KV	20,5	5,54	5,99	23,31	12,64	13,16

Table 2. Statistical parameters scaracterized by wettability of experimental plates – size of drops of saliva – (mm)

STATISTICAL PARAMETERS	COMPARED SERIES OF WARM POLYMERIZED ACRYLAT PLATES					
	SURFACE TREATMENT					
	POLISH ING	SAND BLASTING			METAL-LIZING	SOFT AC-RYLAT
		20’	40’	60’		
NUMBER OF DROPS μ ( )	30	30	30	30	30	30
$\overline{X}$ - SIZE OF DROPS	3.99	5.05	5.50	5.42	5.46	4.94
SD	0.8	0.28	0.37	1.14	0.69	0.65
KV	20.5	5.54	5.99	23.31	12.64	13.16

Tabela 3. Vrednosti t – testa za testiranje serije pločica

t - TEST	KOMPARIRANJE SERIJE				
	POLIRANA PESKIR. 20’	POLIRANA PESKIR. 40’	POLIRANA PESKIR. 60’	POLIRANA METALIZ.	POLIRANA MEKI AKR.
t_o	3,96	8,04	2,65	5,02	3,29
t (α=0.01)	2,7	2,7		2,7	2,7
t (α=0,05)			2,02		

Table 3. Values of t – test for tested series of plates

t - TEST	COMPARED SERIES				
	POLISHED SAND BLAST-ED 20’	POLISHED SAND BLASTED 40’	POLISHED SAND BLASTED 60’	POLISHED METAL-IZED	POLISHED SOFT AKRY-LAT
t_o	3.96	8.04	2.65	5.02	3.29
t (α=0.01)	2.7	2.7		2.7	2.7
t (α=0.05)			2.02		

Na EP obloženim slojem metalnih legura, prosečne vrednosti dijametra kapi ET su nešto iznad onih za ET peskirane 40 s, i, u svakom slučaju, veće nego na poliranim polovinama pločica.

Na pločicama obloženim slojem mekog akrilata vrednosti opserviranog svojstva su nešto veće u odnosu na polirane pločice i bliske vrednostima za peskirane EP 20 s.

Pločice od autopolimerizovanog akrilata pokazuju, u celini, sa malim odstupanjima vrlo slične osobine kao i EP od toplopolimerizovanog akrilata.

Korektivni autopolimerizovan akrilat uslovljava pojavu najvećih prosečnih vrednosti dijametra kapi svih ET i na poliranim, i na peskiranim površinama EP.

Analiza statističkih parametara koji se odnose dijametar kapi pljuvačke na površinama serije toplopolimerizovanih EP koje su, različitim površinskim tretmanima izmenjene, data je na tabelama 2. i 3.

Najveća prosečna vrednost je na pločicama peskiranim 40 s, pa na metaliziranim, itd. U svakom slučaju, te vrednosti su veće na pločicama koje su pretrpele neki površinski tretman u odnosu na grupu poliranih.

Najveće vrednosti t-testa su registrovane u sledećim kompariranim serijama: polirano-peskirane 40 s EP i polirane-metalizirane EP. I preostale tri upoređivane serije, pokazuju statističku značajnost razlika prosečnih vrednosti opserviranog obeležja, ukazujući, indirektno, na stepen kvašljivosti EP, koji je, ipak, najmanji u slučaju peskiranja koje traje 60 s. zatim kod EP obloženih mekim akrilatom i onih peskiranih 20 s.

Ako pokušamo da interpretiramo mehanizam poboljšanja kvašljivosti nahrapavljene površine, moramo da akceptiramo uslove date u eksperimentu. Naime, kap ET konstantne zapremine koja padne sa jednake visine, za sve delove eksperimenta, na nahrapavljenu površinu, posle uspostavljanja ravnoteže sa silama gravitacije i viskoziteta, teži, usled PN, da zauzme oblik najmanje površine da datu zapreminu.

U okolnostima manjeg PN na graničnim površinama tečnost-vazduh i tečnost-čvrsta podloga, nahrapavljena površina će, prema našem mišljenju, umanjiti dejstvo PN tečnosti koji teži da kapljici vrati oblik najmanje površine za datu zapreminu. Naime, nahrapavljanjem EP povećava se ukupna površina dodira sa ET, čime

On EP coated with layer of metal alloys, mean values of drop diameter of EF are slightly above those for EF sand blasted 40 s and, in any case, greater than on polished halves of plates.

On plates coated by layer of soft acrylat the values of observed quality are slightly bigger in relation to polished plates and close to values for sand blasted EP 20 s.

Plates of autopolymerized acrylat show, on the whole, with minor digression, very similar qualities as with EP of warmpolymerized acrylat.

Corrective autopolymerized acrylat conditions appearance of the biggest mean values of drop diameter of all EF as well as on polished ones and on sand blasted surfaces of EP.

Analysis of statistical parameters which concern diameter of saliva drops on surfaces of series of warmpolymerized EP which are, by various surface treatments, changed, given on tables 2 and 3.

The biggest mean value is on plates sand blasted 40 s, then on metallized and so on. In any case, those values are greater on plates which undertook some surface treatment in relation to the group of polished ones.

The biggest values of t-test are registered in the following compared series: polished-sand blasted 40 s EP. Also the remained three compared series show statistical significance of differences of mean values of observed feature, pointing, indirectly, to degree of EP wettability which is, nevertheless, smallest in the case of sand blasting which lasts for 60 s and then with EP coated with soft acrylat and those sand blasted 20 s.

If we try to interpret mechanism of betterment of wettability of roughened surface, we must accept conditions given in the experiment. Namely, EF drop of constant volume which falls from equal height, for all parts of the experiment, on roughened surface, after establishing balance with gravity forces and viscosity tends, because of SV, to take a shape of the smallest surface for given volume.

In circumstances of smaller SV on border surfaces fluid-air and fluid-solid foundation, roughened surface will, as per our opinion, lessen the action of SV fluid which tends to return to the drop the shape of the smallest surface for given volume. Namely, by EP roughening, the total surface of contact with ET is increased by bi se i energija adhezionog rada, pri pokušaju razdvajanja ovih faza, povećala.

S druge strane, izrazito veći stepen hrapavosti dodirne površine tečnost-čvrsto telo, kao i njene iregularnosti, stvorene podminiranim prostorima, može da uslovi i značajnu inkuziju gasnih mehurića sa posledicama, koju proističu iz diskontinuiteta tečnog sloja, kao i mogućih energetskih efekata gasnih jezgri ukoliko dođe do pojave njihove enukleacije, na biofizički aspekat retencije TZP.

U našim eksperimentima, optimalni vremenski interval peskiranja EP od 40 s, izmenom površinske strukture na molekularnom nivou, utiče i na promenu nivoa slobodne površinske energije i poboljšanje uslova kvašljivosti.

Veći stepen kvašljivosti metaliziranih EP bi mogao da se tumači povećanjem njihove površinske energije na graničnoj površini okolni vazduh-čvrsto telo, dok u slučaju mekih akrilata izgleda da postoji njihov veći afinitet u odnosu na molekule adheziva, čime se postiže bolje kvašenje.

Zaključak

U zaključku ukazujemo na potrebnu opreznost pri praktičnoj primeni, u literaturi publikovanih, pokušaja poboljšanja biofizičkih uslovljene retencije, TZP, postupcima peskiranja njene otisnute površine.

Naime, okolnosti kao što su: vreme peskiranja, veličina i fizičko-hemijska svojstva materijala za peskiranje, pritisak pod kojim se on istiskuje iz aparata, udaljenost otisnute površine TZP..., i drugo, imaju praktične implikacije u smislu postizanja i neželjenih (suprotnih) efekata po retenciju TPZ.

which energy of adhesion work would be enlarged with trying to separate these phases.

On the other hand, significantly higher degree of roughness of contact surface fluid-solid body, as well as its irregularity, created with undermined spaces, can condition also important incusion of gas bubbles with consequences coming from discontinuity of fluid layer as well as possible energetic effects of gas cores in case there appears their enucleation, on biophysical aspect of FD retention.

In our experiments, optimum time interval of EP sand blasting of 40 s, by changing surface structure on molecule level, effects also change of level of free surface energy and betterment of conditions of wettability.

Higher degree of wettability of metallized EP could be explained with increase of their surface energy on border surface surrounding air-solid body, while, in the case of soft acrylats, it seems there exists their greater affinity in relation to adhesive molecules by which better wetting is achieved.

Conclusion

In the conclusion, we point to necessary cautiousness during practical application, published in literature, trial to improve biophysically conditioned retention, FD, with procedures of sand blasting of its impressed surface.

Namely, circumstances such as: time of sand blasting, size and physical-chemical qualities of material for sand blasting, pressure under which it is pressed out of apparatus, distance of impressed surface of FD..., and secondly, they have practical implications in the sense of achieving also not desired (opposite) effects on FD retention.

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