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MICROVASCULAR OSTEOCUTANEOUS FLAPS IN THE RECONSTRUCTION OF WAR INJURIES OF THE MANDIBULA

SUMMARY

The paper aims to present the results of microvascular reconstruction of mandibular defects caused by war in former Yugoslavia. We retrospectively analyzed 45 patients with microvascular reconstruction of massive mandibular bone and soft tissue defects during the civil war in Yugoslavia. The defects were reconstructed with 14 scapular, 11 radial forearm, and 20 fibular osteocutaneous flaps. The patients were monitored for three months up to 12 years. The wounds were infected in 8.8% of the patients and bone necrosis occurred in 4.4 %. There was partial bone necrosis in 2.2% of the patients, and nonunion in 4.4%. The patients were hospitalized for 16 to 73 days. The results were considered successful in 96.8 % of the patients.

Microvascular free flap is a versatile method for the reconstruction of massive mandibular bone and soft tissue defects caused by war.

Keywords: **mandibular reconstruction, war trauma, free flaps, vascularized bone graft**

INTRODUCTION

During the civil war in ex-Yugoslavia, a large number of patients was treated at our clinic for injuries to the lower third of the face. Approximately, one third of them required reconstruction of large and small bone and soft tissue defects of the mandibula. The incidence of war injuries of the maxillofacial structures ranges from 8% to 17%, according to the literature (1). In the ex-Yugoslavia civil war the percentage was 10% (2). Since 1993, we have been using free flap reconstruction for large defects of the lower third of the face: scapular, radial, forearm and fibular. Microsurgical free flaps have been extensively used in the reconstruction in this region (3, 4). A growing body of evidence suggests that microvascular osteocutaneous free tissue transfer is the most sophisticated method to reconstruct composite defects of the lower third of the face (5). In peace time, it is also one of the most reliable methods to perform surgery in a single act for tumor ablation in the distal portion of the face, with immediate mandibular reconstruction. The purpose of this study was to demonstrate the results with microvascular free osteocutaneous flaps in the reconstruction of mass mandibular defects and facial soft tissue defects caused by war injuries.

MATERIAL AND METHODS

Our study group consisted of 45 men aged on the average 29 years, with injuries induced by small firearms or explosive devices in the lower third of the face (Figure 1).

All of them had reconstructions with microvascular osteocutaneous flaps during secondary, ie. the phase of reconstructive surgery. We analyzed the lengths of mandibular defects and bone grafts (Figure 2).

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Figure 2. Osseous mandibular defect

We applied scapular, radial forearm composite flap and fibular bone and composite flap

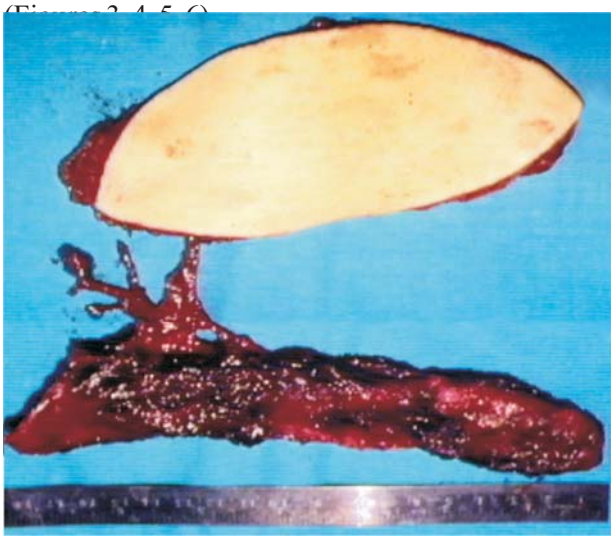

Figure 3. Scapular osteocutaneous flap

The flaps were designed and elevated as usual, in accordance with the dimensions and shape of the defect. Bone transplants were fixated with wires and/or miniplates for mandibular ends. Intermaxillar immobilization was also used in the cases appropriate for that type of immobilization.

Cutaneous parts of the flaps were also used to reconstruct lower lip, chin and/or cheeks. By way of microanastomoses, vascular pedicle (arteries and veins) was attached to the facial artery and vein, or to alternative blood vessels such as retromandibular or lingual veins. Our period of follow-up of the wounded with microvascular flap reconstruction ranged from 3 months to 12 years. Postoperative evaluation involved clinical, radiographic and scintigraphic tests. Clinical parameters were recoreded for each patient separately and involved the complications of microvascular tissue transfer in the recipient and donor regions, duration of hospitalization, bone healing period, functional recovery of speech and food intake, and prosthetic rehabilitation. Bone union, restoration of previous functional status (regular occlusion, chewing and speech), facial and dental contours were the factors against which final outcome was assessed. All the

Figure 6. Vascularized fibular bone graft

RESULTS

We applied scapular, radial forearm composite flaps, fibular osseous or composite flaps in 14, 11 and 20 patients, respectively. The time from primary surgery was, on the average, 25 weeks. Mandibular defects ranged from 5 cm to 16 cm in length. The size of the bone grafts was as follows: scapular from 8 cm to 16 cm (10.2 cm on the average); radial forearm from 5 cm to 11 cm (6.7 cm on the average); and, fibular from 6 cm to 10 cm (8.1 cm on the average). For bone fixation, we used mini-plates (35.6%), wires (26.7%), and their combination (25.6%) (Figures 7-8).

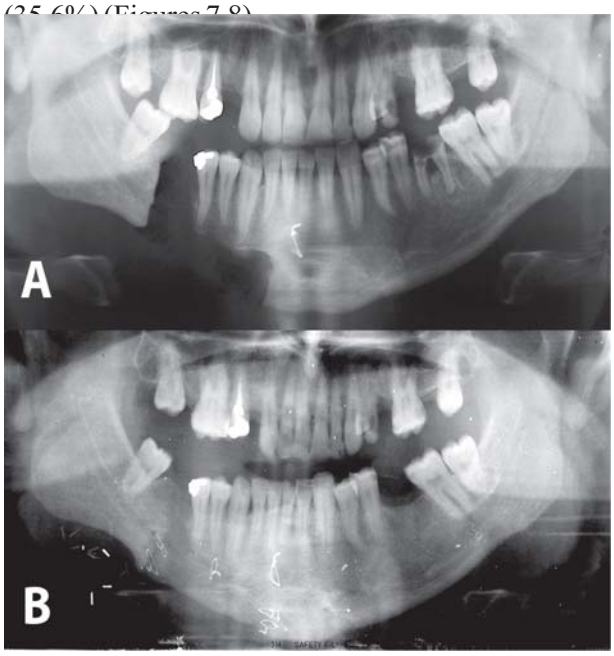

Figure 7. Wire fixation of the bone

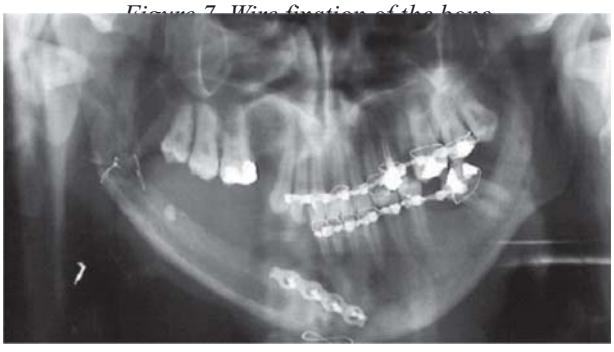

Figure 8. Wire and plate fixation of the bone

In 93.3% of the cases, termino-terminal and in 6.6% termino-lateral microvascular anastomoses were used. Most commonly used recipient blood vessels were facial artery and vein (46.6%), lingual artery and vein (31.1%), external carotid artery and vein (11.1%), superior thyroid artery and vein (6.6%) and ascendent pharyngeal artery and vein (4.4%)

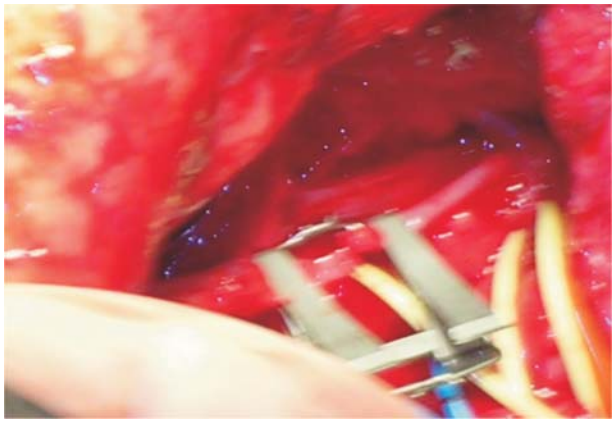

Figure 9. End-to-end microvascular anastomosis

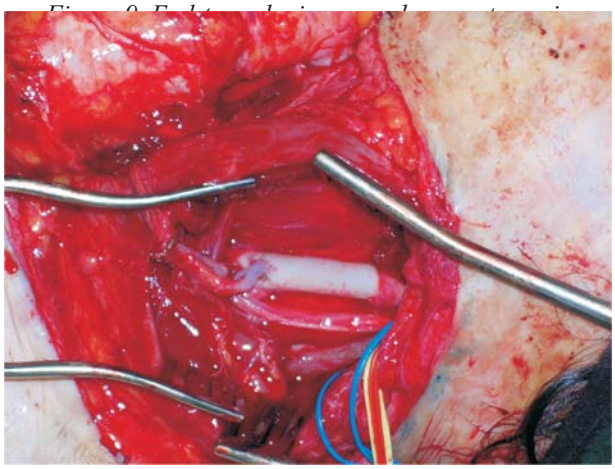

Figure 10. End-to-side microvascular anastomosis

Early postoperative complications were infections (8.8%) and bone necrosis (4.4%). Infections were eliminated by use of antibiotics, and adequate flap vascularization enabled us to replace necrotic skin with local flaps. Late complications were partial bone necrosis in only one case (2.2%), lesion of peroneal nerve in one case (2.2%), and lesion of m. flexor hallucis longus in one case (2.2%). Our patients were hospitalized from 16 to 73 days (mean, 29.9 days). Bone healing process lasted 4.5 to 12.5 months for fibular, 4.5 to 9.5 months for scapular, and 4.5 to 7.5 months for radial bone. After mandibular reconstruction, 86.6% of the wounded could take normal food, while 13.3% could take liquid food after microvascular reconstruction of the mandibula. In 82.2% of the patients speech could be understood, and in 17.7% speech was hardly understandable. Excellent prosthetic results were achieved in 35 patients. Traditional prostheses were applied in 62.85%, implants and mobile prostheses in 25.71%, and implants and fixed prostheses in 11.42% of the wounded.

Primary reconstruction success was achieved in 82.2%, and final success in 96.6% of the wo-

unded.

DISCUSSION

Microvascular osteocutaneous tissue transfer is today artistic work to repair complex defects while defying the stress of mastication (6, 7). The tissue should be of sufficient length, width and hight for defect reconstruction and should be appropriately supplied with blood via the stalk of appropriate length (8). Bone portions of the flap should reflect the contours of the patient's own mandibula, should be easily shaped without compromising blood supply, and cutaneous pedicle should be thin, elastic, and sensitive (9).

Autologous skin graft techniques involve the use of tissue which has to be removed from a healthy spot, which produces significant morbidity of the donor region and causes unilateral defects to become bilateral (10). However, unavoidable morbidity of the region donating these osteocutaneous flaps is less significant weighed against the reconstruction advantages. Their incorporation into the mandibular defect is the most reliable method to achieve single-act procedure, early reconstruction of the mandibula, which is still a golden standard (11), probably until the development of new methods which will utilize vascularized tissue of engineered (or artificial) mandibular grafts (12, 13). Although there are various indications for non-vascularized bone grafts (NVBG) and vascularized bone grafts (VBG) in mandibular reconstruction, comparisons of these techniques could be based on bone union and general success of the implant. An evaluation of a relatively large cohort of patients with NVBG or VBG indicated successful bone union in 69% for NVBG and 96% for VBG ($p<0.001$), and also higher general success rates for VBG compared to NVBG (99% vs 82%, $p<0.001$) (14). Our experience with NVBG and VBG in mandibular reconstruction is similar to the above-mentioned results. We achieved success in primary reconstruction of the mandibula in 50% for NVBG compared to 82.25% for VBG, and finally in 67.2% for NVBG vs 96.6% for VBG, respectively (15).

Vascularized osteocutaneous radial forearm flap was usually used in the reconstruction of complex bone and soft tissue defects of the lower third of the face because of extraordinary quality of its cutaneous components (16-18). We performed reconstruction of mandibular defects caused by war activities with vascularized osteocutaneous radial flap and achieved primary success in 87.5% and complete success in 100% of the cases (16) (Figures 11, 12, 13).

Figure 11. Soft tissue and bone defect of the mandibular region

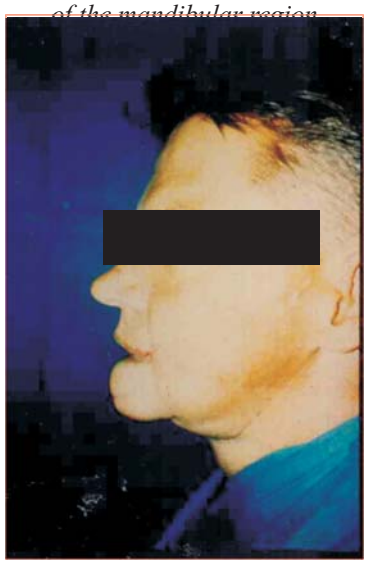

Figure 12. Reconstructed mandible with radial forearm osteocutaneous flap

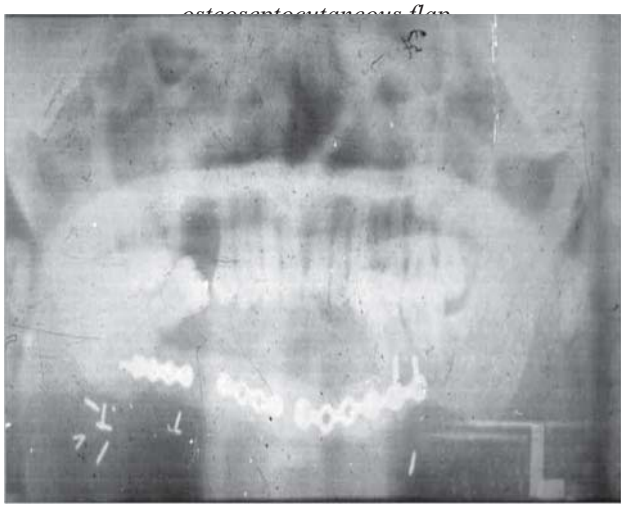

Figure 13. Ortopan radiograph of the lower jaw after

the reconstruction with radial forearm flap

Microvascular reconstruction without peri- or postoperative complications was considered primary success, while complete success denotes the final result of mandibular reconstruction (with or without peri- or postoperative complications). Microvascular osteocutaneous scapular flap was believed to be appropriate for the reconstruction of mandibular defects with massive loss of the skin and mucosa due to its rich blood supply, adaptability and mobility of its cutaneous components (Figures 14, 15, 16) (3, 8, 17, 19).

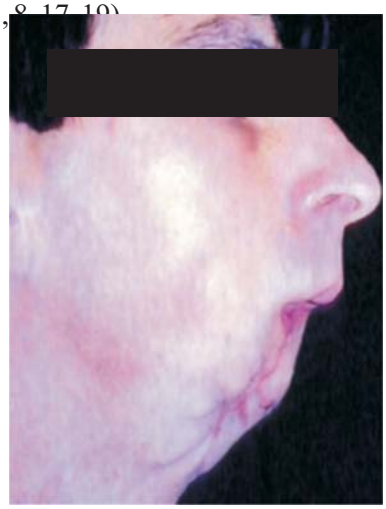

Figure 14. Soft tissue and bone defect

Figure 15. Reconstructed mandible with scapular

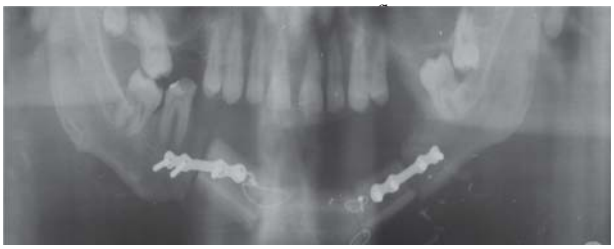

Figure 16. Ortopan-radiograph of the lower jaw after the reconstruction with scapular osteocutaneous flap

The fibula is an ideal bone for mandibular reconstruction. In cases where mandibula was not available or when only a small piece of bone was required, other options were taken into account (20, 21). The fibula is therefore ideal for microvascular tissue transfer since it provides sufficient height (22). The length of 20-30 cm of the bone can be sacrificed, the shape of the bone is maintained along its length and its segmental vascularization allows for multiple osteotimies (22, 23). The flap can be used to fill in the defect from one angle to another; it is also appropriate for osteointegrated dental implants since it is sufficiently wide and high (24). The use of fibular graft in the reconstruction of posttraumatic mandibular defects gave excellent results in our study in view of functional recovery and mandibular strength (25, 26) (Figures 17, 18, 19).

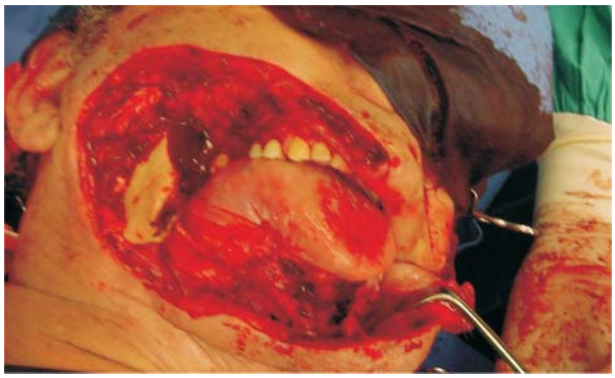

Figure 17. Large soft tissue and bone defect of the mandibule

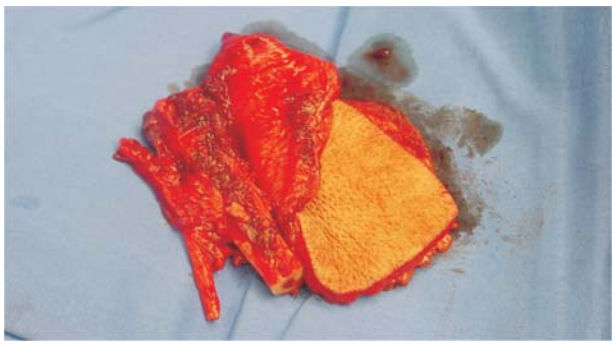

Figure 18. Fibular osteoseptocutaneous flap

Figure 19. Microsurgical reconstruction with fibular osteoseptocutaneous flap

Excellent long-term functional results (mastication, maintenance of bone volume, speech) and esthetic results (Figures 20, 21) have been proven after more than 10 years of assessment (27).

Figure 20. Appearance before reconstruction

Figure 21. Appearance after reconstruction

CONCLUSION

Our results support the use of microvascular reconstruction methods in the management of war wounds. These methods should be applied in the management of small firearm wounds, wounds after explosions, and in peace. Since the resections of malignant tumors can cause similar, massive bone and soft tissue defects, microvascular reconstruction is here highly applicable and is currently gaining support in oncologic surgery of this region.

REFERENCES

1. Stosic S. Rekonstrukcija mandibule [Mandibular reconstruction]. Beograd, Rubikon, 2005: p 2. Serbian.
2. Panajotovic Lj. Ratne rane sa defektom tkiva [War wounds with tissue defects]. In: Dragovic M, Todoric M (eds): Urgentna i ratna hirurgija [Urgent and War Surgery], Beograd, Velarta, 1998, p 89. Serbian.
3. Wells MD. Part I. Mandibular reconstruction using vascularized bone grafts. J Oral Maxillofac Surg 1996; 54:883.
4. Genden E, Haughey BH: Mandibular reconstruction by vascularized free tissue transfer.Am J Otolaryngol 1996;17:219.
5. Gurtner GC, Evans GR. Advances in head and neck reconstruction.Plast Reconstr Surg 2000;106:672.
6. Kuriloff DB, Sullivan MJ. Mandibular reconstruction using vascularized bone grafts. Otolaryngol Clin North Am 1991;24:1391.
7. Moran CG, Wood MB. Vascularized bone autografts.Orthop Rev 1993;22:187.
8. Schuepbach J, Dassonville O, Poissonnet G, Demard F. Early postoperative bone scintigraphy in the evaluation of microvascular bone grafts in head and neck reconstruction. Head Face Med 2007;3:20.
9. Forrest C, Boyd B, Manktelow R, Zuker R, Bowen V. The free vascularised iliac crest tissue transfer: donor site complications associated with eighty-two cases. Br J Plast Surg 1992;45:89.
10. Li Z, Zhao Y, Yao S, Zhao J, Yu S, Zhang W. Immediate reconstruction of mandibular defects: a retrospective report of 242 cases. J Oral Maxillofac Surg 2007;65:883.
11. Tsue TT: Transfer, Osteocutaneous Radial Forearm Flap. eMedicine from WebMD. Available from URL: http://www.emedicine.com/ent/topic720.htm, Jan 7, 2008.
12. Warnke PH, Springer IN, Wiltfang J, Acil Y, Eufinger H, Wehmöller M, Russo PA, Bolte H, Sherry E, Behrens E, Terheyden H. Growth and transplantation of a custom vascularised bone graft in a man. Lancet 2004;364:766.

13. Gronthos S. Reconstruction of human mandible by tissue engineering.Lancet 2004;364:735.

14. Stosic S. Rekonstrukcija mandibule [Mandibular reconstruction]. Beograd, Rubikon, 2005: 88, Serbian.

15. Stosic S: Rekonstrukcija mandibule [Mandibular reconstruction]. Beograd, Rubikon, 2005: 116, Serbian.

16. Stosic S, Kozarski J, Stosic-Opincal T, Jovic N, Kozomara R. [Microvascular osteoseptocutaneous radial flap in reconstruction of mandible following war injury] Vojnosanit Pregl 2005; 62:429, Serbian.

17. Mounsey RA, Boyd JB. Mandibular reconstruction with osseointegrated implants into the free vascularized radius. Plast Reconstr Surg 1994;94:457.

18. Nakatsuka T, Harii K, Yamada A, Ueda K, Ebihara S. Dual free flap transfer using forearm flap for mandibular reconstruction. Head Neck 1992;14:452.

19. Stosic S, Jovic N, Stosic-Opincal T, Kozomara R, Panajotovic Lj. [Vascularised osteocutaneous scapular flap in the reconstruction of mandibular defects after war wounding] Acta Chir Iugosl 2005 ; 52:47, Serbian.

20. Li L, Blake F, Heiland M, Schmelzle R, Pohlenz P. Long-term evaluation after mandibular reconstruction with fibular grafts versus microsurgical fibular flaps.J Oral Maxillofac Surg 2007;65:281.

21. Militsakh ON, Werle A, Mohyuddin N, Toby EB, Kriet JD, Wallace DI, Girod DA, Tsue TT. Comparison of radial forearm with fibula and scapula osteocutaneous free flaps for oromandibular reconstruction. Arch Otolaryngol Head Neck Surg 2005;131:571.

22. Nakayama B, Matsuura H, Hasegawa Y, Ishihara O, Hasegawa H, Torii S: New reconstruction for total maxillectomy defect with a fibula osteocutaneous free flap. Br J Plast Surg 1994; 47:247.

23. Gbara A, Darwich K, Li L, Schmelzle R, Blake F. Long-term results of jaw reconstruction with microsurgical fibula grafts and dental implants. J Oral Maxillofac Surg 2007;65:1005.

24. Jones NF, Monstrey S, Gambier BA. Reliability of the fibular osteocutaneous flap for mandibular reconstruction: anatomical and surgical confirmation. Plast Reconstr Surg 1996; 97:707.

25. Stosic S, Novakovic M, Jovic N, Mirkovic Z, Bogeski T, Loncarevic S, Cvetinovic M. Vascularized fibular graft in the reconstruction of posttraumatic mandibular defects.Vojnosanit Pregl 1997; 54:27, Serbian.

26. Said M, Heffelfinger R, Sercarz JA, Abemayor E, Head C, Blackwell KE. Bilobed fibula flap for reconstruction of through-and-through oromandibular defects. Head Neck 2007; 29:829.

27. Smith JE, Ducic Y. Mandibular reconstruction, Plating. eMedicine from WebMD. Available from URL: http://www.emedicine.com/ent/ topic743.htm, February 5, 2007.

MIKROVASKULARNI OSTEOKUTANI REŽNJEVI KOD REKONSTRUKCIJA RATNIH POVREDA MANDIBULE

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SAŽETAK

Ovaj rad predstavlja prikaz rezultata mikrovaskularne rekonstrukcije defekata mandibule uzrokovanih ratnim dejstvima u bivšoj Jugoslaviji. Retrospektivno je analizirano 45 pacijenata kod kojih je učinjena mikrovaskularna rekonstrukcija masivnih defekata mandibule i mekih tkiva tokom civilnog rata na prostorima bivše Jugoslavije. Defekti tkiva su rekonstruisani sa 14 skapularnih, 11 radijalnih podlakatnih i 20 fibularnih osteokutanih režnjeva. Pacijenti su praćeni od 3 meseca do 12 godina. Infekcija rane bila je prisutna kod 8.8%, a koštana nekroza kod 4.4% pacijenta. Parcijalna nekroza kosti u 2.2% i nespajanje u 4.4% pacijenta. Pacijenti su hospitalizovani od 16 do 73 dana. Rezultati su smatrani uspešnim u 96.8% pacijenata.

Mikrovaskularna transplantacija slobodnog režnja je veoma primenljiva metoda u rekonstrukciji masivnih koštanih defekata mandibule uzrokovanih ratnim dejstvima.

Ključne reči: **rekonstrukcija mandibule, ratne povrede, slobodni režnjevi, vaskularizovani koštani graft**