Primljen / Received on: 24. 9. 2024.
Revidiran / Revised on: 20. 10. 2024.
Prihvaćen / Accepted on: 26. 10. 2024.

PRIKAZ SLUČAJA
CASE REPORT
doi: 10.5937/asn2591054T

PROCENA KVALITETA NOVOFORMIRANE ALVEOLARNE KOSTI POSLE PRIMENE „LEPLJIVE KOSTI“ – PRIKAZ SLUČAJA

QUALITY EVALUATION OF NEWLY FORMED BONE AFTER “STICKY BONE” SOCKET PRESERVATION: A CASE REPORT

Stavre Trajculeski[1], Daniela Veleska Stevkovska[2], Biljana Evrosimovska[2]

[1]UNIVERZITETSKI STOMATOLOŠKI KLINIČKI CENTAR „SVETI PANTELEJMON“, ODELJENJE ZA ORALNU HIRURGIJU I IMPLANTOLOGIJU, SKOPLJE, SEVERNA MAKEDONIJA
[2]STOMATOLOŠKI FAKULTET, UNIVERZITET SV. KIRIL I METODIJ, SKOPLJE, SEVERNA MAKEDONIJA

[1]UNIVERSITY DENTAL CLINICAL CENTER “SAINT PANTELEJMON”, DEPARTMENT OF ORAL SURGERY AND IMPLANTOLOGY, SKOPJE, NORTH MACEDONIA
[2]FACULTY OF DENTISTRY,SS. CYRIL AND METHODIUS UNIVERSITY, SKOPJE, NORTH MACEDONIA

Sažetak

Uvod: *Resorpcija preostalog alveolarnog grebena nakon ekstrakcije zuba izraženija je u horizontalnom nego u vertikalnom pravcu. Proces je vremenski zavisan, a najintenzivniji je tokom prvih šest meseci i u prvoj godini nakon vađenja zuba. Za očuvanje zapremine alveolarne kosti koriste se različiti graft materijali, kao što su autografti, allografti, ksenografti i aloplastični materijali. A-PRF, kao autologni derivat krvi, poslednjih godina sve se češće primenjuje zbog svojih svojstava koja doprinose angiogenezi, epitelizaciji i hemostazi. Njegova jednostavna priprema, niska cena i odsustvo potrebe za antikoagulansima čine ga pogodnim za široku kliničku primenu.*
Cilj *ovog rada bio je da se ispita uticaj A-PRF-a kao adjuvansa na količinu i kvalitet novostvorene kosti u postupku očuvanja alveole nakon ekstrakcije zuba.*
Materijal i metode: *Očuvanje alveole (socket preservation) izvedeno je kombinacijom A-PRF-a i ksenografta u obliku tzv. „lepljive kosti” (sticky bone). Nakon intervencije evaluirani su klinički parametri, gustina kosti i histomorfometrijski pokazatelji kvaliteta novostvorene kosti.*
Rezultati: *Klinička merenja pokazala su smanjenje širine alveolarnog grebena za 1 mm, bez vertikalne resorpcije, četiri meseca nakon očuvanja alveole. Zabeležena je veća gustina novonastale kosti u poređenju sa gustinom kosti u periapikalnoj regiji, kao i odličan kvalitet kosti prema histomorfometrijskoj analizi.*

Ključne reči: *A-PRF, ksenograft, lepljiva kost, gustina kosti, histomorfometrija*

Abstract

Introduction: *Residual alveolar ridge bone resorption is more prominent in the horizontal, than the vertical direction. It is time-dependent, and most prominent in the first six months and the first year after tooth extraction. Several graft materials are used for keeping residual alveolar bone volume, like autografts, allografts, xenografts, alloplastic materials, etc. A-PRF as an autologous blood derivative, has been increasingly used in recent years because of its properties in angiogenesis, epithelialization and hemostasis. Simple production, low cost and non-use of anticoagulants are advantages for more mass use of it.*
Aim: *The aim was to investigate the impact of PRF as an adjuvant on bone quantity and quality in socket preservation.*
Materials and Methods: *Socket preservation with a combination of A-PRF with xenograft (sticky bone) was performed, and clinical parameters, bone density and histomorphometry were evaluated.*
Results: *Clinical measurements showed 1 mm horizontal and no vertical resorption four months after socket preservation, higher density of newly formed bone than bone density of periapical region and great bone quality based on histomorphometric analysis.*

Key words: *A-PRF, xenograft, sticky bone, bone density, histomorphometry*

Corresponding author:
Dr. Stavre Trajculeski, PhD
University Dental Clinical Center ”St. Panteleimon” Skopje
17 Vodnjanska St., Skopje
Republic of North Macedonia
E-mail: stavre.trajculeski@gmail.com

Introduction

Tooth extraction, for various etiological reasons, is the most commonly performed oral surgical procedure in everyday dental practice[1].

Following the extraction of the indicated tooth, the healing phases of the post-extraction wound begin, which have been studied extensively in numer of animal and human studies. The healing process of the post-extraction wound has been described in four phases in some studies and review papers, while the 2015 review by Araujo et al.[2] detailed the histological changes in three phases: the inflammatory phase, proliferative phase, and bone modelling and remodelling.

Bone resorption is more pronounced in the first six months after extraction, and continues at a rate of 0.5–1% per year throughout life[3,4].

In 2012, Lang et al., in a systematic review study, determined the following dimensional changes in the residual alveolar ridge after tooth extraction over six months: a 3.8 mm mean resorption in the horizontal (vestibulo-oral) projection; and a 1.24 mm mean value for vertical (coronal-apical) resorption[5].

In recent decades, with the development of technical and technological processes, the enormous rise and development of implantology, implant prosthetics and aesthetic dentistry have become inevitable, as has the ever-increasing need to preserve the so-called red-and-white aesthetics, and the need to preserve or create the biological foundation. In the last decade, in the field of implantology and implant prosthetics, long-term personal satisfaction or the so-called satisfaction rate has become increasingly important, and not just success and longevity, or the so-called success rate. From an aesthetic point of view, especially in the frontal region, the preservation of the so-called red-white aesthetics, which Furhauser et al. assesses through the Pink Esthetic Score (PES), is of key importance. This evaluates the condition of peri-implant soft tissues, while Belser et al. in 2009 introduced their simplified index for quantifying parameters for evaluating soft tissues and implant-prosthetic structure through the so-called White Esthetic Score (WES)[6,7].

In order to meet the aesthetic and functional needs of patients, the correct prosthetic placement of implants plays a key role. This has led to the need to develop two separate methods for preserving and creating the biological foundation, namely guided bone regeneration (GBR) and guided tissue regeneration (GTR). GBR methods, are divided into two separate methods: augmentation of the residual alveolar ridge (ARA), which involves increasing the volume of the ridge and is applied after a longer period of bone resorption, and preservation of the residual alveolar ridge (ARP), which involves the maximum possible preservation of the contours of the post-extraction alveolus immediately after tooth extraction[8]. Post-extraction socket grafting, or socket preservation (SP), as a segment of ARP, has become increasingly popular in recent decades due to its conceptual and technical attractiveness[9].

Several types of biomaterials have been used and investigated in a number of clinical studies, including autologous bone, or autografts (AG), allografts (AlG), xenografts (XG), alloplastic materials (AlP), autologous blood derivatives, and bioactive agents[10].

Characteristic of XG is their slow resorption and the presence in situ of 20% to 40% of the graft material during the first six months and presence up to 3 years, and in a longitudinal study, their presence has been proven even 18 months after application[11,12].

The history of autologous blood derivatives begins in the early 1970s with the innovation of fibrin glue until 2001, when Dr. Joseph Choukroun in France innovated PRF (Platelet Rich Fibrin) as the second generation of autologous blood derivatives, and further modification of production protocols. The PRF protocol is a physiological method based on the use of centrifugal force to fractionate the blood elements of platelet-enriched fibrin in specially designed tubes, lined with glass on the inside, unlike the complicated procedure of obtaining PRP[13]. The mechanism of action of PRF is through its structure and composition. It is a network of densely arranged fibrin fibers with a three and a tetramolecular structure in which a huge number of platelets and leukocytes are incorporated. By degranulating platelets from their dense α-granules, plasma proteins, pro- and anti-inflammatory cytokines (IL-1, IL-6, IL-4, IL-8), and growth factors (TGF, VEGF, PDGF, IGF) are released[14].

The properties of these components that make up the PRF coagulum are in inflammatory response and improvement, as well as the acceleration of bone and soft tissue

healing of the post-extraction wound, and th elimination of postoperative morbidity.

In order to improve the efficiency of different types of grafts, barrier membranes and biomaterials, as well as the combination of their osteogenic, osteoinductive and osteoconductive properties, there is often a need for mutual combination with the ultimate goal of improved results of the final outcome of GBR and GTR procedures.

Aim

The aim was to analyse the impact of PRF as an adjuvant on bone quantity and quality in socket preservation.

Materials and Methods

A 50-year-old male patient came to our clinic with pain, hyperemia and mild swelling on the left side of the lower jaw. Clinical examination revealed the presence of pain, local hyperemia and mild swelling in the area of tooth 36, which was tender to palpation and painful on vertical percussion. An ortho-pantomography was performed revealing an irreparable chronic periapical lesion (Figure 1). Extraction of the tooth was indicated with further socket preservation and subsequent implant-prosthetic rehabilitation. After the acute local infection subsided, oral surgical extraction and socket preservation with sticky bone as a xenograft mix (BioOss, Geistlich) in combination with A-PRF+ was carried out (Figure 2).

The A-PRF+ protocol involved venipuncture from the cubital vein into 2 specially designed 10 ccm A-PRF tubes, centrifuged in a centrifuge (BIOBASE) at 1300 rpm/8 minutes. The supernatant was collected with a sterile syringe, and 2 PRF membranes were prepared from the PRF coagulum in a PRF box. One membrane was chopped into small pieces and mixed with the xenograft and saturated to the desired consistency with the supernatant as sticky bone. Sticky bone was applied to the post-extraction alveolus, covered with the other PRF membrane, and a stabilizing X-suture was placed (Figure 3 and Figure 4).

After 4 months, implantation with an Ankylos implant was performed. Three months after implantation, the prosthetic super-structure was fabricated (Figure 4). After one year follow-up, clinically was detected a perfect condition of periimplant and peri-prosthetic soft tissues. Retroalveolar radiography was performed with significant bone condensation around the implant surface (Figure 5).

Figure 1. Orthopantomography

Figure 2. Sticky bone preparation

Figure 3. Application of sticky bone

Figure 4. Covering with PRF membrane

Figure 4. Superstructure over dental implant

Figure 5. Retroalveolar roentgenography

Results

Immediately after the intervention, the clinical width of the residual alveolar ridge was evaluated. The measurement was performed with a bone measurement caliper in a vestibulo-oral direction. To evaluate the height of the residential alveolar ridge, a graduated periodontal probe was used to measure the distance from the cement-enamel limit of the adjacent tooth to two points: one on the buccodistal side and the other on the oral distal side, up to the top of the interdental septum. The mean distance between these two points was calculated. In addition, the height of the interdental papilla was measured and noted with a periodontal probe, from the cemento-enamel limit of the adjacent tooth to the highest point of the interdental papilla. The same clinical parameters were measured 4 months postoperatively (Table 1).

During preparation of the implant site, a bone biopsy was taken with a 2 mm trephine burr and sent for histomorphometric analysis (Figures 6 and 7). The following results were obtained:

- residual xenograft was not identified
- 70% of newly formed bone
- 20% woven bone
- 10% connective tissue
- 2–3 giant cells
- 5–6 osteoblasts
- 2 osteoclasts

Four months post-operatively, the quality of the newly formed bone was evaluated with the help of CBCT, 3D imagination technique, Owandy I-MAX 2/3D, and software support Quickvision 2/3D (Owandy radiology, Croissy-Beaubourg France) by notifying bone density expressed in Hounsfield units (Figures 8 and 9, Table 2).

Table 1. Clinical parameters of the measurements performed

	Immediate postoperative	4 months postoperative
Horizontal dimension	14 mm	13 mm
Vertical dimension	3 mm	3 mm
Papilla height	1 mm	1 mm

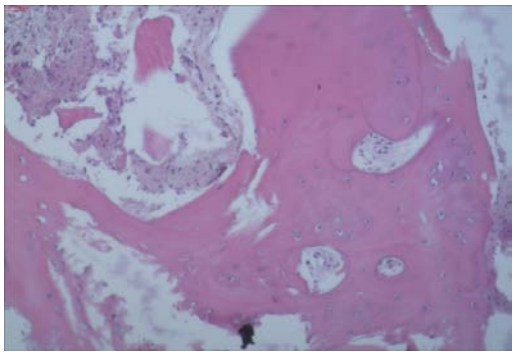

Figure 6. Histomorphometric analyses

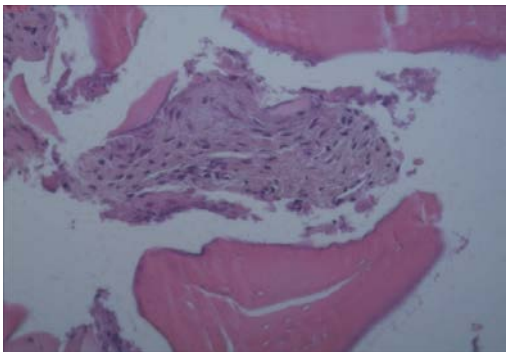

Figure 7. Histomorphometric analyses

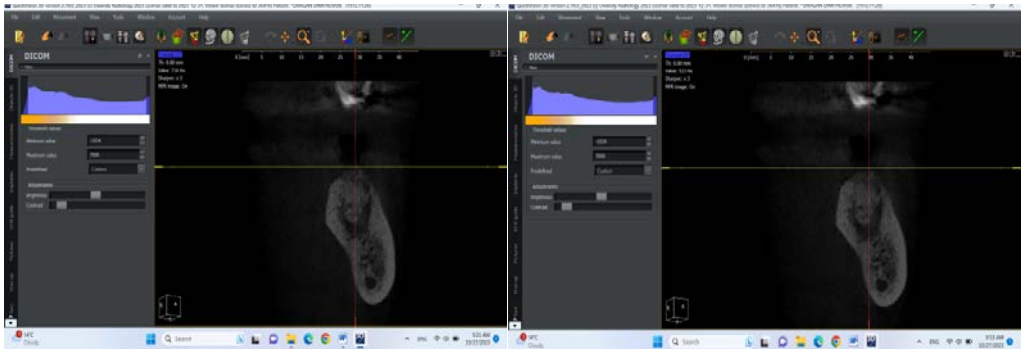

Figure 8. CBCT bone density-socket ***Figure*** 9. CBCT bone density- periapical

Table 2. Evaluation of the density of the newly formed bone

	CBCT 4 months postoperative
Post-extraction alveola	716 HU
Periapical region	533 HU

Discussion

Platelet-enriched fibrin, through its histomorphological characteristics, i.e., its three- and tetramolecular structure, in which 97% of platelets and more than 50% of leukocytes are captured and concentrated, plays a major role in the process of healing of the post-extraction wound, both in hard and soft tissues[15].

Growth factors released by platelet degranulation, from their dense α-granules, play a key role in neocollagenesis and neosteogenesis through their impact on fibroblast and osteoblast activity[16]. The presence of plasma proteins, growth factors, and cytokines in PRF plays a key role in the processes of hemostasis, angiogenesis, and epithelialization, thereby significantly affecting the healing processes of the post-extraction wound, thus finding application in oral and maxillofacial surgery[17].

In their study, Dohan et al.[18] describe PRF acting like a lymph node, which is able to stimulate defense mechanisms. It is even likely that the significant inflammatory regulation noted on surgical sites treated with PRF is the outcome of retro control effects from cytokines trapped in the fibrin network and released during the remodeling of this initial matrix. Cytokines play a significant role in the delicate balance of tissue homeostasis[18].

From the clinical measurements obtained, the improved effectiveness of the particulate graft in combination with PRF is notable, as in improving its properties in terms of preserving the volume of post-extraction alveoli, and smaller bone resorption in a horizontal and vertical direction.

The density of newly formed bone in 52 subjects with preserved post-extraction alveoli with different graft materials (DBBM, HA, collagen membrane, and non-grafted) four months postoperatively was evaluated using CBCT in a study by Cavdar et al. 2017. It concluded that the highest value of newly formed bone density was in the HA group, but that this was due to the presence of residual graft material that compromised the true value expressed in HU[19].

In an animal clinical study by Araujo and Lindhe[20] in 2011, a clinical and histomorphometric comparative analysis of preserved post-extraction alveoli with autograft and Bio-Oss was performed in experimental dogs. The analysis took place three months postoperatively, with bone biopsies being collected to evaluate the composition of the newly formed bone. The results indicated that the alveoli preserved with autograft (bone chips) showed a composition of 57.2 ± 8.6% mineralized bone, 38.3 ± 10.9% bone marrow and 1.9 ± 1.9% non-vital autograft particles. In contrast, the grafted alveoli treated with Bio-Oss exibited composition of 43.1% ± 10% mineralized bone, 16 ± 7.6% bone marrow, and 24.4 ± 3.7% residual xenograft. The xenograft material was surrounded by connective tissue and giant cells indicating a foreign body reaction that played a role in the resorption of residual graft particles. From a clinical perspective, the results show increased bone resorption of the alveoli augmented with autograft compared to those augmented with Bio-Oss[20].

In 2009, Nevins et al. examined the efficacy of PDGF-BB on Bio-Oss Collagen, and bone biopsies were taken after 4 and 6 months, with a large amount of new bone formation observed after four months (23.2 ± 3.2% new bone and 9.5 ± 9.1% residual graft material), and after six months (18.2 ± 2.1% new bone and 17.1 ± 7.0% residual graft) on histological analysis[21].

In 2021, a study conducted by Jose Ponte et al. used histomorphometric analysis to compare three different graft materials. The first examined group received only PRF, the second group used sticky bone, and the third group utilized a particulate graft covered with a collagen membrane. The results showed a significant difference in effectiveness with PRF achieving a success rate of (68.83%). In contrast, the sticky bone group had a success rate of 35.69%, while the group using the particulate graft and collagen membrane recorded only 16.28%)[22].

In 2016, Ahmed Halim Ayoub and Soulafa Mohamed Belal in a case report of a patient with an indication for the extraction of an irreparable root of tooth[23], and the need for further implant-prosthetic treatment, described socket preservation with sticky bone by using a combination of particulate allograft and PRF. Clinical and radiological examinations were performed after the intervention itself and a control CBCT before the implant therapeutic procedure. Results were obtained for minimized horizontal and vertical bone loss, as well as high-quality newly formed bone[23].

Large number of prognostic factors has been identified, which may be related to the success of GBR, like patient-related factors, level of hygiene, level of dental plaque, smoking habits etc[24].

Conclusion

The combination of A-PRF with a particular xenograft has superior properties in terms of the quality of the newly formed bone.

***Acknowledgement*:** None.

Conflict of interest: None.

Source of funding: None

LITERATURA/REFERENCES

1. Buchwald S, Kocher T, Biffar R, Harb A, Holtfreter B, Meisel P. Tooth loss and periodontitis by socioeconomic status and inflammation in a longitudinal population-based study. J Clin Periodontol. 2013 Mar;40:203–11
2. Araújo MG, Silva CO, Misawa M, Sukekava F. Alveolar socket healing: what can we learn? Periodontol 2000. 2015 Jun;68(1):122-34.
3. Schropp L, Wenzel A, Kostopoulos L, Karring T. Bone healing and soft tissue contour changes following single-tooth extraction: a clinical and radiographic 12-month prospective study. Int J Periodontics Restorative Dent. 2003 Aug;23(4):313-23.
4. Ashman A. Postextraction ridge preservation using a synthetic alloplast. Implant Dent. 2000;9(2):168-76.
5. Lang, N.P., Pun, B.L., Lau, I.K.Y., Li, K.Y. & Wong, M.C.M. (2012) A systematic review on survival and success rates of implants placed immediately into fresh extraction sockets after at least one year. Clinical Oral Implants Research 23(Suppl. 5): 39–66.
6. Fürhauser R, Florescu D, Benesch T, Haas R, Mailath G, Watzek G. Evaluation of soft tissue around single-tooth implant crowns: the pink esthetic score. Clin Oral Implants Res. 2005 Dec;16(6):639-44.
7. Buser D, Martin W, Belser UC. Optimizing esthetics for implant restorations in the anterior maxilla: anatomic and surgical considerations. Int J Oral Maxillofac Implants. 2004;19 Suppl:43-61.
8. Hämmerle CH, Araújo MG, Simion M; Osteology Consensus Group 2011. Evidence-based knowledge on the biology and treatment of extraction sockets. Clin Oral Implants Res. 2012 Feb; 23 Suppl 5:80-2. Erratum in: Clin Oral Implants Res. 2012 May;23(5):641.
9. Christensen GJ. Ridge preservation: why not? J Am Dent Assoc 1996: 127: 669–670
10. Darby I, Chen ST, Buser D. Ridge preservation techniques for implant therapy. Int J Oral Maxillofac Implants 2009: 24 (Suppl.): 260–271.
11. AlGhamdi, A.S.; Shibly, O.; Ciancio, S.G. Osseous grafting part II: Xenografts and alloplasts for periodontal regeneration—A literature review. J. Int. Acad. Periodontol. 2010; 12; 39–44.
12. van Steenberghe D, Callens A, Geers L, et al. The clinical use of deproteinized bovine bone mineral on bone regeneration in conjunction with immediate implant installation. Clin Oral Implants Res 2000; 11: 210-6
13. Marx RE. Platelet-rich plasma: evidence to support its use. J Oral Maxillofac Surg. 2004;62:489–496
14. Dohan DM, Choukroun J, Diss A, Dohan SL, Dohan AJ, Mouhyi J, Gogly B. Platelet-rich fibrin (PRF): a second-generation platelet concentrate. Part II: platelet-related biologic features. Oral Surg Oral Med Oral Pathol Oral Radiol Endod. 2006 Mar;101(3):e45-50.
15. Ehrenfest DM, Del Corso M, Diss A, Mouhyi J, Charrier JB. Three-dimensional architecture and cell composition of a Choukroun's platelet-rich fibrin clot and membrane. J Periodontol. 2010;81(4):546-55.
16. Kawase T, Okuda K, Wolff LF, Yoshie H. Platelet-rich plasma-derived fibrin clot formation stimulates collagen synthesis in periodontal ligament and osteoblastic cells in vitro. J Periodontol. 2003;74(6):858-64.
17. Del Corso M, Vervelle A, Simonpieri A, Jimbo R, Inchingolo F, Sammartino G, et al. Current knowledge and perspectives for the use of platelet-rich plasma (PRP) and platelet-rich fibrin (PRF) in oral and maxillofacial surgery part 1: Periodontal and dentoalveolar surgery. Curr Pharm Biotechnol. 2012;13(7):1207- 30.
18. Dohan DM, Choukroun J, Diss A, Dohan SL, Dohan AJ, Mouhyi J, et al. Platelet-rich fibrin (PRF): A second-generation platelet concentrate. Part III: Leucocyte activation: A new feature for platelet concentrates? Oral Surg Oral Med Oral Pathol Oral Radiol Endod. 2006;101(3):e51-5.
19. Cavdar FH, Keceli HG, Hatipoglu H, Demiralp B, Caglayan F. Evaluation of Extraction Site Dimensions and Density Using Computed Tomography Treated With Different Graft Materials: A Preliminary Study. Implant Dent. 2017 Apr;26(2):270-274.
20. Araújo MG, Lindhe J. Socket grafting with the use of autologous bone: an experimental study in the dog. Clin Oral Implants Res. 2011 Jan;22(1):9-13.
21. Nevins ML, Camelo M, Schupbach P, Kim DM, Camelo JM, Nevins M. Human histologic evaluation of mineralized collagen bone substitute and recombinant platelet-derived growth factor-BB to create bone for implant placement in extraction socket defects at 4 and 6 months: a case series. Int J Periodontics Restorative Dent. 2009 Apr;29(2):129-39.
22. Ponte JS, Pérez-Guerrero JA, Aragão FA, Menezes YA, Melo MM, Castro-Silva II. Histomorphometric evaluation of human extraction sockets treated with autologous fibrin, sticky bone or biphasic calcium phosphate. Acta Odontol Latinoam. 2021 Dec 31;34(3):271-281. English.
23. Ayoub, Ahmed & Belal, Soulafa. (2016). Clinical and Radiographic Evaluation of Socket Preservation Using Autologous Concentrated Growth Factors Enriched Bone Graft Matrix (Sticky Bone): A Case Report. EC Dental Science. 5. 1128-1135.