Original Article
MedInform
DOI: 10.18044/MEDINFORM.2025122.2127
ISSUE 2, 2025

Alveolar Ridge Resorption Following Dental Extraction

Ivaylo Parushev[1], Ralitsa Yotsova[2], Tsvetalina Gerova-Vatsova[3]

1. Department of Clinical Medical Sciences, Faculty of Dental Medicine, Medical University of Varna, Bulgaria
2. Department of Oral Surgery, Faculty of Dental Medicine, Medical University of Varna, Bulgaria
3. Department of Periodontology and Dental Implantology, Faculty of Dental Medicine, Medical University of Varna, Bulgaria

Abstract

The alveolar crest is tooth-related, and the tooth extraction causes its horizontal and vertical resorption. This poses numerous challenges regarding the masticatory function, speech, and digestion, as well as deteriorating the patient's esthetics, self-esteem, and psychological health. This article aims to evaluate the amount of vertical bone resorption following tooth extraction in both socket walls for 3 months using cone-beam computed tomography (CBCT). Twenty patients requiring a premolar or molar extraction were enrolled in this study (twelve men and eight women, aged 31-65 years). The surgery included atraumatic tooth extraction (including root separation in multi-rooted teeth) under infiltration anesthesia. The CBCT scans (Planmeca Pro Max 3D) were performed twice, following the extraction and 3 months after. The comparison of the buccal wall height for 3 months presented a significant bone resorption of 3.5 ± 2 mm ($t = 8.7$, $p < 0.0001$). For the oral wall, the resorption was 2.1 ± 1 mm ($t = 9.3$, $p<0.0001$). The estimated correlation between the vertical bone loss of both walls was weak and statistically insignificant (Pearson's $\rho = 0.2$, $p = 0.3$). The mean difference between the resorptions was statistically significant – 1.4 mm ($t = 3$; $p = 0.005$), suggesting that the resorption in the control group did not proceed evenly, but was more pronounced in the buccal wall. A weak, statistically insignificant correlation was established between the resorption of the buccal and palatal/lingual plates, demonstrating that they did not affect each other.

Keywords: alveolar crest resorption, alveolar ridge resorption, bone atrophy, tooth extraction

Introduction

The alveolar crest is tooth-related, and the tooth extraction causes its horizontal and vertical resorption, leading to significant dimensional alterations if left untreated (1, 2). The so-called "bundle bone" and the periodontal ligaments are resorbed 15 days following tooth loss (3). The resorption is an irreversible process that causes vertical crest reduction up to 5 mm and horizontal reduction up to 3 mm. This poses numerous challenges regarding the masticatory function, speech, and digestion, as well as deteriorating the patient's esthetics, self-esteem, and psychological health

DOI: 10.18044/MEDINFORM.2025122.2127 ISSUE 2, 2025

(4-7). The causative factors include afunctional bone atrophy, impaired blood supply, and inflammatory response (8). The resorption rate varies individually and is 4 times greater in the mandible compared to the maxilla (9, 10). The resorption is more pronounced in the buccal alveolar wall than the oral (palatal or lingual) wall, which can be attributed to the difference in their width and shape (thinner, sharper, and lacking cancellous bone on the buccal aspect). Dehiscences and fenestrations, which are more common in the buccal bone, additionally promote its remodeling processes (11-13).

Aim

This article aims to evaluate the amount of vertical bone resorption following tooth extraction in both socket walls for 3 months using cone-beam computed tomography (CBCT).

Material and Methods

The research was conducted at the Faculty of Dental Medicine in Medical University – Varna, Bulgaria, following ethical approval № 118/ 23/06/22. The registration protocol can be accessed on ClinicalTrials.gov (NCT06621498).
Twenty patients requiring a premolar or molar extraction were enrolled in this study. The inclusion criteria consisted of the following: patients aged 18-65 years, requiring an extraction of a posterior tooth; good general health; and written informed consent. The exclusion criteria were as follows: general and/or local contraindications for oral surgery, the patient's refusal to sign an informed consent, or unwillingness to participate.
Twelve men and eight women (aged 31-65) participated in the study. The average age was 51 ± 12 years.
The surgery was performed by a single oral surgeon (R.Y.) and included atraumatic tooth extraction (including root separation in multi-rooted teeth) under infiltration anesthesia with Articaine 4%, socket debridement and rinsing. The sockets were sutured using polyamide suturing material (5/0). The post-surgical instructions included a soft diet and good oral hygiene. The participants were prescribed appropriate antibiotics (Augmentin 1000 mg twice daily for a week/ clindamycin 300 mg three times a day for 5-7 days/ azithromycin 500 mg once daily for 3 days) according to their general health and allergy status, non-steroidal anti-inflammatory drugs, and mouthwash containing 0.12% chlorhexidine.
The CBCT scans (Planmeca Pro Max 3D) were performed twice, following the extraction and 3 months after. The Planmeca Romexis software was used for analysis of the results. The vertical dimensions of both socket walls were measured on paraxial slices in the socket center. The measures were taken from the upper border of each wall to some permanent anatomical landmarks (maxillary sinus or mandibular canal) (Figure 1). In sockets with preserved inter-radicular septa, the measurements were performed both medially and distally, leading to more measurements than the extracted teeth.

DOI: 10.18044/MEDINFORM.2025122.2127 ISSUE 2, 2025

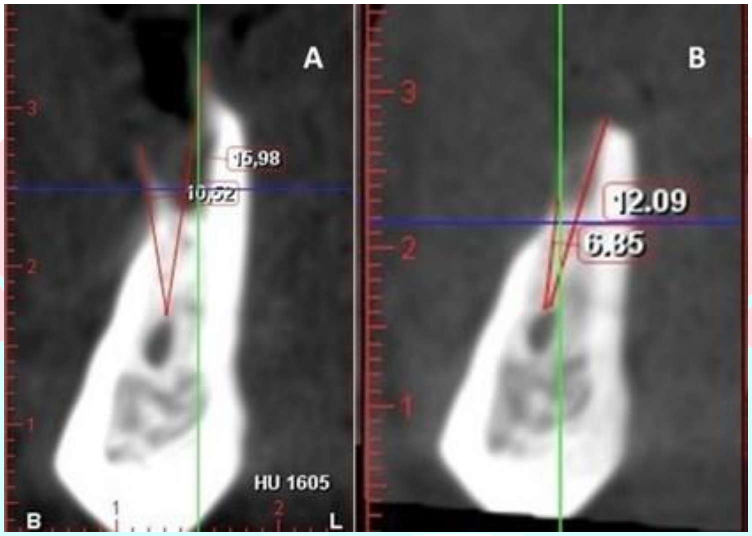

Figure 1. Measurement of the vertical socket heights (A – immediately after the extraction, B – after a 3-month healing period)

The results were presented by measures of descriptive statistics and parametric tests (the t-test, the Pearson correlation) using IBM SPSS v.25.0 and MS Office Excel 2016. The determined significance level was p = 0.05.

Results

The estimated mean height of the buccal wall on the extraction day was 13.4 ± 4.5 mm. The average palatal/lingual height was 13.5 ± 4.6 mm. The mean buccal and palatal/lingual heights after 3 months were 9.9 ± 4.2 mm and 11.5 ± 4.5 mm, respectively.
The comparison of the buccal wall height for 3 months presented a significant bone resorption of 3.5 ± 2 mm ($t = 8.7$, $p < 0.0001$). For the oral wall, the resorption was 2.1 ± 1 mm ($t = 9.3$, $p<0.0001$) (Table 1). These results demonstrate that the post-extraction resorption was more pronounced buccally.

Table 1. Socket wall height on the day of extraction and after a 3-month healing time.

Height	Time	N	Mean	SD	Mean diff.	SD	Std. Error Mean	95% CI		t	*p*
								L	U		
Buccal	**Day 0**	24	13.4	4.5	3.5	2	0.4	2.6	4.3	8.7	<0.0001
	Day 90		9.9	4.2							
Oral	**Day 0**		13.5	4.6	2.1	1	0.2	1.6	2.6	9.3	<0.0001
	Day 90		11.5	4.4							

DOI: 10.18044/MEDINFORM.2025122.2127 ISSUE 2, 2025

The bone resorptions of both buccal and palatal/lingual socket plates are graphically presented using box plots in Figure 2.

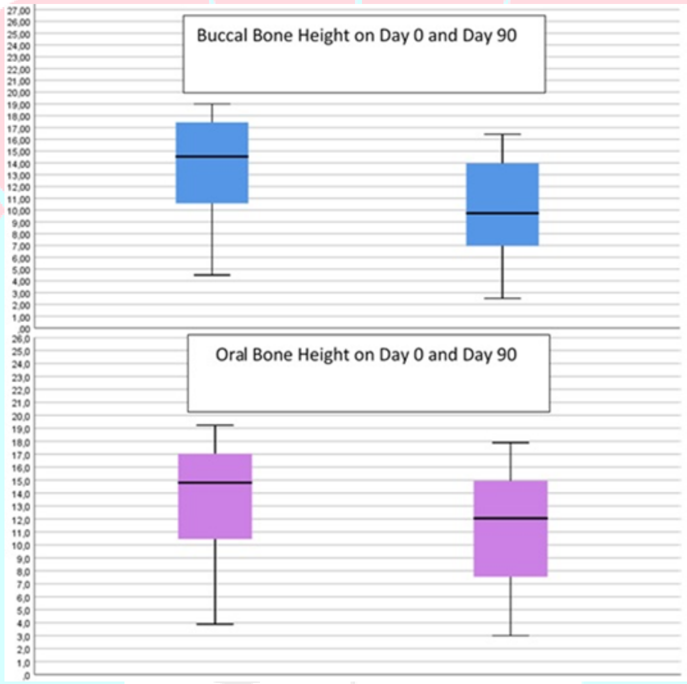

Figure 2. Box plots of socket wall heights on day 0 and day 90.

The estimated correlation between the vertical bone loss of both walls was weak and statistically insignificant (Pearson's $\rho = 0.2$, $p = 0.3$).
The mean difference between the resorptions was statistically significant - 1.4 mm ($t = 3$; $p = 0.005$).

Discussion

After tooth extraction, the alveolar bone proper covering the post extraction socket ("bundle bone") is rapidly resorbed (14) due to cellular remodeling, which leads to clinically visible volumetric changes of the premolar and molar regions of the alveolar crest with up to 50% loss of width in the first year (15).
CBCT is a suitable tool for three-dimensional measurement and assessment of the alveolar ridge. It provides high-resolution images that allow for the assessment of intraoral hard tissues, including buccal plate width (16-18).
In this research, the vertical bone loss in both plates was of a very high statistical and clinical significance. In the buccal wall, it was 3.5 ± 2 mm, while in the palatal/lingual wall, it was 2.1 ± 1 mm.
This difference in the resorption of the two plates was consistent with the studies of Araujo and Lindhe (15). They described volumetric changes in the alveolar crest during the first 8 weeks after the extraction of mandibular premolars. The increased osteoclastic activity during this period leads

DOI: 10.18044/MEDINFORM.2025122.2127 ISSUE 2, 2025

to resorption of the buccal and oral socket walls, with the vertical bone loss being more pronounced in the buccal plate. Histological results show that the crestal region of the buccal bone plate consists predominantly of alveolar bone proper, while in the lingual plate it is a combination of bundle bone and supporting bone (19-21).

In this study, a statistically significant difference was found between the vertical resorption of the plates, with the mean difference between them being 1.4 mm. The conclusion is that the resorption did not proceed evenly, but was more pronounced in the buccal wall.

A weak, statistically insignificant correlation was established between the resorption of the buccal and palatal/lingual plates, suggesting that they did not affect each other.

Barone et al. (22) reported vertical resorption of 2.1 ± 0.7 mm in the buccal wall and 2.0 ± 0.7 mm in the lingual wall.

Controversially, other authors reported lower resorption values – between 1.67 and 1.74 mm for the buccal bone and 1.53 mm for the lingual wall (23-25).

This study has some limitations, such as the short follow-up period (3 months) and the relatively small sample size. Future clinical studies should address these limitations and investigate the main factors influencing post-extraction resorption and the possible preventive strategies.

Conclusion

Post-extraction bone resorption is an inevitable phenomenon whose extent and severity depend on the individual characteristics, different local and systemic factors. The vertical bone resorption found in this study was of a very high statistical and clinical significance for both socket walls; still, it was more pronounced in the buccal plate. Future clinical studies should investigate the factors influencing post-extraction bone resorption and give some recommendations for prevention and treatment.

References

1. Vignoletti F, Matesanz P, Rodrigo D, Figuero E, Martin C, Sanz M. Surgical protocols for ridge preservation after tooth extraction. A systematic review. Clin Oral Implants Res. 2012 Feb;23 Suppl 5:22-38.
2. Course PC. Dental Implantology of the Croatian Medical Association. Acta stomatol Croat. 2022;56(3):318-36.
3. Balli G, Ioannou A, Powell CA, Angelov N, Romanos GE, Soldatos N. Ridge Preservation Procedures after Tooth Extractions: A Systematic Review. Int J Dent. 2018 Jul 3;2018:8546568.
4. Ten Heggeler JM, Slot DE, Van der Weijden GA. Effect of socket preservation therapies following tooth extraction in non-molar regions in humans: a systematic review. Clin Oral Implants Res. 2011 Aug;22(8):779-88.
5. De Angelis P, De Rosa G, Manicone PF, De Giorgi A, Cavalcanti C, Speranza A, et al. Hard and soft tissue evaluation of alveolar ridge preservation compared to spontaneous healing: a retrospective clinical and volumetric analysis. International Journal of Implant Dentistry. 2022 Dec 8;8(1):62.

DOI: 10.18044/MEDINFORM.2025122.2127 ISSUE 2, 2025

6. El-Sioufi I, Oikonomou I, Koletsi D, Bobetsis YA, Madianos PN, Vassilopoulos S. Clinical evaluation of different alveolar ridge preservation techniques after tooth extraction: a randomized clinical trial. Clinical Oral Investigations. 2023 Aug;27(8):4471-80.
7. Lin Y, Li G, Xu T, Zhou X, Luo F. The efficacy of alveolar ridge split on implants: a systematic review and meta-analysis. BMC oral health. 2023 Nov 20;23(1):894.
8. Ashman A. Postextraction ridge preservation using a synthetic alloplast. Implant Dent. 2000;9:168–176.
9. Atwood DA, Coy WA. Clinical, cephalometric, and densitometric study of reduction of residual ridges. J Prosthet Dent. 1971; 26:280–295.
10. Tallgren A. The continuing reduction of the residual alveolar ridges in complete denture wearers: a mixed-longitudinal study covering 25 years. J Prosthet Dent. 1972;27:120–132.
11. Hong H, Zhou J, Fan Q, Jiao R, Kuang Q, Zhou H, et al. Characteristics of spatial changes in molars and alveolar bone resorption among patients with loss of mandibular first molars: A CBCT-based morphometric study. Journal of clinical medicine. 2023 Mar 1;12(5):1932.
12. Araujo MG, Wennström JL, Lindhe J. Modeling of the buccal and lingual bone walls of fresh extraction sites following implant installation. Clinical oral implants research. 2006 Dec;17(6):606-14.
13. García-González S, Galve-Huertas A, Centenero SA, Mareque-Bueno S, Satorres-Nieto M, Hernández-Alfaro F. Volumetric changes in alveolar ridge preservation with a compromised buccal wall: a systematic review and meta-analysis. Medicina Oral, Patología Oral y Cirugía Bucal. 2020 Jul 19;25(5):e565.
14. Cardaropoli G, Araújo M, Lindhe J. Dynamics of bone tissue formation in tooth extraction sites: an experimental study in dogs. Journal of clinical periodontology. 2003 Sep;30(9):809-18.
15. Araújo MG, Lindhe J. Dimensional ridge alterations following tooth extraction. An experimental study in the dog. J Clin Periodontol. 2005 Feb;32(2):212-8.
16. Timock AM, Cook V, McDonald T, Leo MC, Crowe J, Benninger BL, Covell Jr DA. Accuracy and reliability of buccal bone height and thickness measurements from cone-beam computed tomography imaging. American journal of orthodontics and dentofacial orthopedics. 2011 ;140(5):734-44.
17. Alshomrani F. Cone-Beam Computed Tomography (CBCT)-based diagnosis of dental bone defects. Diagnostics. 2024 Jul 1;14(13):1404.
18. Rathi S, Hatcher D. Radiographic Evaluation of the Alveolar Ridge in Implant Dentistry: CBCT Technology. Essential Techniques of Alveolar Bone Augmentation in Implant Dentistry: A Surgical Manual. 2022 Sep 14:40.
19. Novaes Jr AB, Macedo GO, Suaid FA, Barros RR, Souza SL, Silveira e Souza AM. Histologic evaluation of the buccal and lingual bone plates in anterior dog teeth: possible influence on implant dentistry. Journal of periodontology. 2011 Jun;82(6):872-7.
20. Ramalingam S, Sundar C, Jansen JA, Alghamdi H. Alveolar bone science: Structural characteristics and pathological changes. InDental Implants and Bone Grafts 2020 Jan 1 (pp. 1-22). Woodhead Publishing.
21. Merheb J, Quirynen M, Teughels W. Critical buccal bone dimensions along implants. Periodontology 2000. 2014 Oct;66(1):97-105.

DOI: 10.18044/MEDINFORM.2025122.2127 ISSUE 2, 2025

22. Barone A, Toti P, Quaranta A, Alfonsi F, Cucchi A, Negri B, et al. Clinical and Histological changes after ridge preservation with two xenografts: preliminary results from a multicentre randomized controlled clinical trial. J Clin Periodontol. 2017 Feb;44(2):204-214.
23. Jambhekar S, Kernen F, Bidra AS. Clinical and histologic outcomes of socket grafting after flapless tooth extraction: a systematic review of randomized controlled clinical trials. J Prosthet Dent. 2015 May;113(5):371-82.
24. Majzoub J, Ravida A, Starch-Jensen T, Tattan M, Suarez-Lopez, Del Amo F. The influence of different grafting materials on alveolar ridge preservation: a systematic review. J Oral Maxillofac Res.2019;10(3):e6.
25. van der Weijden F, Dell'Acqua F, Slot DE. Alveolar bone dimensional changes of post-extraction sockets in humans: a systematic review. J Clin Periodontol. 2009 Dec;36(12):1048-58.

Corresponding author:

Ralitsa Yotsova
MU-Varna, 84 Tsar Osvoboditel blvd.
Faculty of Dental Medicine
Department of Oral Surgery
Tel.: +359889242600;
e-mail: r.yotsova@abv.com