DIMENSIONAL CHANGES OF THE ALVEOLAR CREST FOLLOWING TOOTH EXTRACTION – A CONE-BEAM COMPUTED TOMOGRAPHY STUDY

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Keywords: *ridge remodeling, alveolar crest, resorption, dental extraction, CBCT*

Abstract: *Introduction: Tooth loss causes important changes in the alveolar crest by means of resorption, atrophy and bone formation. This study aims to analyse the remodeling pattern of the alveolar crest following tooth extraction by means of CBCT. Materials and methods: Fifty CBCT full arch scans were analysed, 25 for the mandible and 25 for the maxilla. They belonged to 40 partially edentulous patients, 22 women and 18 men. The edentulous alveolar ridge was compared to the dentate site on the opposite side of the arch in curved slice mode. Horizontal and vertical measurements were recorded. Results and discussions: In the maxilla, the mean reduction of the bony crest was 2 mm horizontally and 3.2 mm vertically. In the mandible, the mean values were 2.9 mm in width and 3.4 mm in height. Women displayed higher values of bone loss as compared to men. A limited number of missing teeth leads to small dimensional changes, whereas 4 or more missing consecutive teeth may cause a massive collapse of the alveolar crest. Free-end edentulous sites lose more bone than interleaved ones. The prosthetic status plays an important role in ridge remodeling, with removable restorations causing the greatest collapse of the alveolar crest and the implants the least bone loss. Conclusions: Following tooth extraction, ridge remodeling affects the buccal plate and the vertical dimension of the alveolar crest. Several physiologic variables and local clinical aspects influence the bone loss.*

INTRODUCTION

The dento-alveolar crest has an important role in retaining the teeth, thus in mastication, deglutition, phonetics and esthetics, by tooth display and by giving a proper support for the perioral soft tissues. The loss of teeth can cause important changes of the alveolar bone, affecting all the functions mentioned above and posing great challenges in restoring a normal appearance by means of implant dentistry or prosthodontics.

The process of postextractional healing implies resorption, atrophy and bone formation. Following tooth extraction, granulation tissue fills the alveolus in 4 to 5 days. In about 3 weeks, the epithelial tissue covers the site. After 6 weeks, new bone begins to develop inside the alveolus.(1) Research has shown that in most cases, the bone volume of the edentulous ridge is greater than the one during the dentate state, since the dental root itself had occupied an important part of the dento-alveolar crest. However, the loss of volume appears most of the time and it generally affects the buccal and vertical aspect.

Resorption is defined as a reduction of an organ following the loss of the function it was meant for. Atrophy, on the other hand, is the diminution of an organ due to nutritional deficiency.(2) After tooth extraction, both resorption and atrophy of the alveolar crest take place: the bone loses its' primary function of retaining the dental root and also one important source of nutrition, which is the periodontal vessels. The most affected areas are thin cortical plates, especially on the buccal side.

Research has shown that the alveolar bone is subject to physiological remodeling as a reaction to mechanical stimuli, especially occlusal forces.(3) The masticatory forces are transferred to the periodontal ligament, which causes tension in the internal walls of the alveolus. These bony areas show an increased presence of osteoblasts and osteoid tissue. Muscular insertions also produce tensions inside the bone. Studies have shown that a decrease in muscle activity may lead to bone loss as a result of a diminished osteoblast activity and an enhanced osteoclast function.(4) Areas that are subject to pressure tend to resorb, whereas tension determine bone formation.

The dimensional changes of the alveolar crest begin right after tooth extraction. In the first year, the width of the crest reduces with about 2-3 mm, after which the process is considerably diminished to 0.1-0.2 mm every year.(5-9) These changes are highly dependent on the previous tooth pathology, the extraction technique, the chronology of tooth loss and on the type and quality of the prosthetic treatment. Multiple extractions in the maxillary frontal region can cause a dramatic bone loss, reaching almost 70% in width and length.

A threshold was established of 2 mm for minimal thickness of the cortical plate that would ensure a natural healing process without the loss of volume of the alveolar crest.(7) However, all maxillary teeth and mandibular premolars and frontals display a thin cortical plate on the buccal side, which leads to dimensional changes after tooth extraction. Only the distal root of the first mandibular molar and the second

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Article received on 22.07.2019 and accepted for publication on 02.09.2019
ACTA MEDICA TRANSILVANICA September;24(3):107-110

inferior molar may be embedded in a sufficiently thick bone that would withstand ridge remodelling.(10-17)

Modern three-dimensional imaging techniques help clinicians to better understand the case and to develop a treatment plan that would best suit the patient's needs. Cone-beam computed tomography (CBCT) technology offers the possibility to explore the cases and better understand the anatomy and pathology of the case.(18-21)

AIM

This study aims to analyse the remodeling pattern of the alveolar crest following tooth extraction by means of CBCT. Bone loss will be observed in relation physiologic variables and local clinical aspects such as the configuration of the edentulous ridge and the prosthetic status.

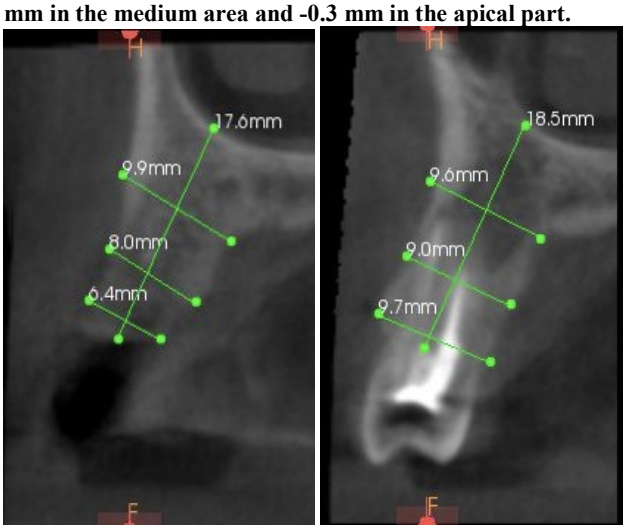
MATERIALS AND METHODS

Fifty CBCT full arch scans were analysed, 25 for the mandible and 25 for the maxilla. They belonged to 40 partially edentulous patients, 22 women and 18 men, aged between 24 and 73 years. The CBCT scans were requested to evaluate the surgical sites for implant treatment. The tomographic volumes were analysed using the CS Imaging software.

The edentulous alveolar ridge was compared to the dentate site on the opposite side of the arch in curved slice mode. On the cross-sectional slices of the tomography, measurements were performed, both on the edentulous side and on the dentate side: the height of the ridge and the width in the apical, medium and coronal part of the crest. The amount of resorption was calculated as the difference between the values obtained from the dentate site and those of the edentulous site.

Aside from the amount of resorption, several data were collected: the age and sex of the patient, the missing teeth and the type of edentation, the time from extraction and the type of prosthesis that replaced the missing teeth.

Figures no. 1,2. An example of the measurements performed on cross-sections of the edentulous ridge of 14 (Figure no 1) and of 24 (Figure no 2). The height and the width of the crest were measured. The amount of resorption was calculated as the difference between the dentate crest and the edentulous ridge. In this case, the vertical resorption was 0.9 mm, while the horizontal resorption was 3.3 mm in the crown region, 1 mm in the medium area and -0.3 mm in the apical part.

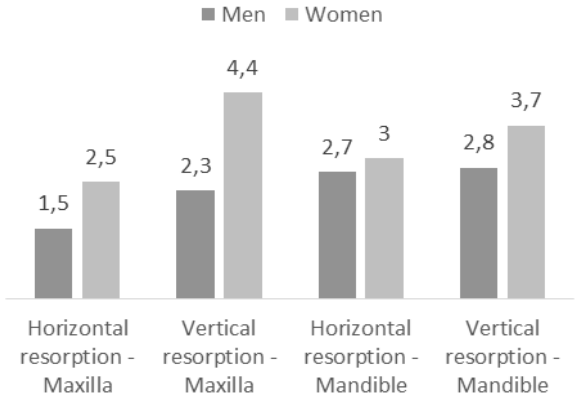


RESULTS AND DISCUSSIONS

The bone loss was measured both horizontally and vertically. In the maxilla, the mean reduction of the bony crest was 2 mm horizontally and 3.2 mm vertically. In the mandible, the mean values were 2.9 mm in width and 3.4 mm in height. The dimensional changes of the alveolar crest following tooth extraction were more important in the mandible, both in vertical and horizontal direction. Ridge remodeling affected mostly the buccal wall because during the dentate state there is a thin buccal cortical plate that is vascularized by the periodontal vessels. Extraction causes an important reduction in the nutrition of the bony plate and this segment of the alveolar crest loses the function of retaining the tooth, which leads to atrophy and resorption.

Several variables have been analysed and the results are illustrated in the charts below: the patient's gender, the type and extent of the edentulous space and the prosthetic status.

Figure no. 3. Mean values of bone loss in relation to gender



Women displayed higher values of bone loss as compared to men. This is due smaller dimensions of the bone, especially a thinner buccal bony plate, which is prone to resorb following tooth extraction. Women often display a thin gingival phenotype, which causes an increased loss in volume after tooth loss. An unfavourable calcium metabolism, especially at menopause, may also lead to an increased ridge remodeling after extraction.

Figure no. 4. Resorption pattern in correlation to the configuration of the edentulous space. In this chart, a lateral edentation is limited by teeth on both ends, while terminal represents a free-end situation.

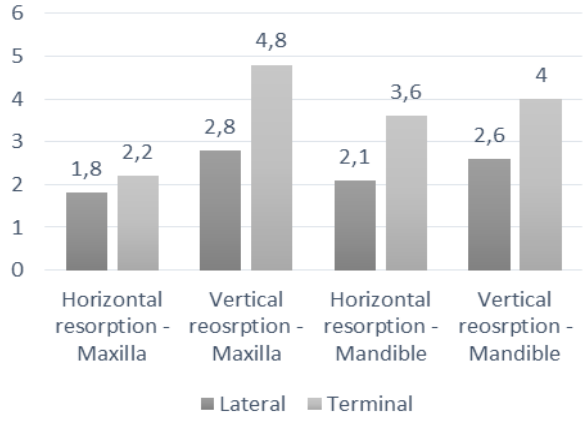
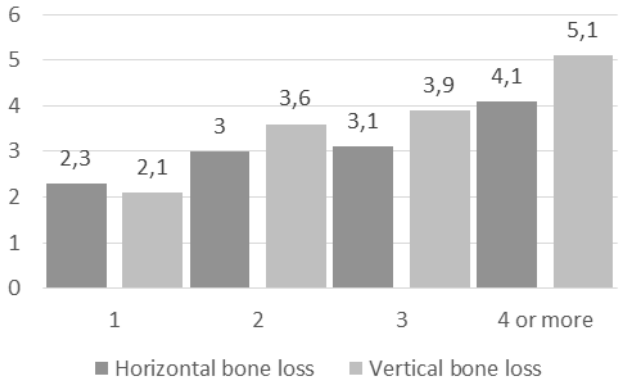
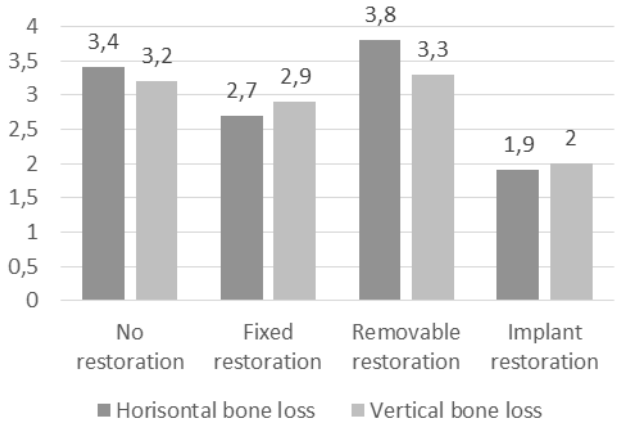


Figure no 5. Mean values of bone loss in relation to the number of missing teeth



The configuration of the edentulous site seems to play an important role in the amount of alveolar volume that is lost. A limited number of missing teeth leads to small dimensional changes, whereas 4 or more missing consecutive teeth may cause a massive collapse of the alveolar crest. Research have indicated that in order to maintain the bone anatomy, a daily mechanical stimulation must take place.(3) Remaining teeth stimulate the alveolar crest and the closer they are to the edentulous ridge, the more they prevent bone loss. In our study, a free-end edentulous area displayed significantly greater bone loss when compared to an interleaved edentation. An important decrease in the height of the alveolar crest was observed in the maxilla, in free-end edentulous situations. In these cases, the diminution of the bone height is related both to the reduction of the crest from the coronal aspect and to the pneumatization of maxillary sinus.

Figure no. 6. Prosthetic status of the edentulous crest and dimensional changes of the alveolar crest



Another factor that proved to have a major impact on bone loss is the type of prosthetic restoration corresponding to the edentulous area. The most aggressive bone loss was observed when removable restorations were used. This is due to the fact that the saddle of the removable denture puts pressure on the alveolar crest and thus facilitates a loss in volume. No restoration also caused an increased amount of bone loss. Our study showed that the presence of a fixed restoration would limit the dimensional changes of the crest. Photo-elastic studies have indicated that under a pontic, the edentulous crest is subjected to a biomechanical stress, which may stimulate the bone and reduce resorbtion.(8) The smallest dimensional changes were observed when implants were inserted in the edentulous bone, which suggest that implants stimulate the bone and thus best maintain the alveolar architecture. Implants cause a considerable improvement of the tactile function of the bone within the first few months following restoration.(9) This indicates a functional stimulation of the bone, which leads to a better masticatory function.

CONCLUSIONS

Following tooth extraction, ridge remodeling affects the buccal plate and the vertical dimension of the alveolar crest. Bone loss is higher in women than in men. The number of missing teeth and the configuration of the edentulous site affects the dimensional changes. The prosthetic status plays an important role in ridge remodeling, with removable restorations causing the greatest collapse of the alveolar ridge and the implants the least bone loss.

Acknowledgement:

In this article, all the authors have equal contribution with the first author.

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