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REVIEWS

FACTORS INFLUENCING POSTEXTRACTION ALVEOLAR RIDGE RESORPTION

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ABSTRACT

INTRODUCTION: Postextraction resorption is an irreversible process that causes a reduction in alveolar ridge width and height and, thus, can pose functional and aesthetic challenges for future implant and prosthetic rehabilitation. The resorption rate varies between individuals and between different time intervals within the same individual. Various factors have been reported to influence the resorption process.

AIM: This review aims to discuss the factors influencing postextraction alveolar bone resorption and compare their significance.

MATERIALS AND METHODS: An electronic search using Web of Science, PubMed, Scopus, and Google Scholar databases was conducted until May 2024. This review includes 40 articles. It summarizes the scientific evidence on the reviewed topic.

RESULTS: Postextraction resorption depends on numerous system and local factors, the most common of which are the extent of surgical trauma, morphological features of the socket, presence of infection, type and position of the tooth, periodontal biotype, type and time of prosthetic treatment, and some metabolic disorders and bad habits, such as smoking.

Further research is necessary to determine how the knowledge of the factors influencing postextraction resorption can be used as a predictive factor for the expected amount of bone loss, and the exact methods that can prevent such resorption, such as ridge preservation, immediate implant placement, etc.

CONCLUSION: Postextraction alveolar ridge resorption is an inevitable process that can hinder the implant and prosthetic rehabilitation of the dentition. Understanding the factors influencing this process can assist ridge preservation after tooth loss and the rehabilitation of the dentition.

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INTRODUCTION

The alveolar ridge is a tooth-dependent structure that undergoes significant alterations after tooth loss (1). Healing after extraction is characterized by intrinsic changes leading to the formation of bone in the socket and extrinsic ones leading to a reduction in the width and height of the alveolar ridge. Two integral components of the socket—the bundle bone and periodontal ligaments, disappear during the first two weeks after the extraction (2). Postextraction resorption is an irreversible process that causes a reduction in alveolar ridge width and height and, thus, can pose functional and aesthetic challenges for future implant and prosthetic rehabilitation (3).

When the buccal plate thickness is less than 1 mm, vertical resorption of 7.5 mm can be expected by the eighth week after extraction. If the buccal bone thickness exceeds 1 mm, the vertical resorption is only 1.1 mm (4).

The resorption rate varies between individuals and between different time intervals in the same individual. Resorption is believed to start from the buccal plate, to be greater in width than in height, and to proceed more rapidly in the mandible (5). It has been reported that after the extraction of a single tooth, up to 50% of the width of the alveolar crest will be resorbed, with bone resorption predominantly from the buccal aspect (6). Furthermore, there is a marked difference in resorption in the upper and lower jaw. Socket walls in the lower jaw resorb up to four times faster than those of the upper jaw (7). If no measures are taken to prevent this phenomenon, 40–60% of alveolar bone volume is lost in the first 2–3 years after extraction (8). It has not been completely understood which factors influence postextraction ridge resorption and to what extent.

AIM

This review discusses and summarizes the factors influencing alveolar bone resorption after tooth extraction and compares their significance.

MATERIALS AND METHODS

Data sources included four electronic databases (Web of Science, PubMed, Scopus, and Google Scholar). Articles in English, containing the selected keywords were screened and assessed for eligibility by four independent reviewers. Discrepancies between the reviewers were resolved by discussion and consensus. This review article includes 40 studies.

RESULTS AND DISCUSSION

Atwood and Coy (1971) divided the factors that affect the degree of postextraction resorption into four categories, including anatomical, metabolic, functional, and prosthetic. Anatomical factors include the thickness of the mucosa overlying the crest, socket depth, number of extracted teeth, and alveolar crest size, shape, and density. Metabolic factors influence the osteoblast and osteoclast activity through nutritional, hormonal, and other metabolic influences. Functional factors include intensity, duration, frequency, and direction of the forces exerted on the bone. The cellular activity, bone formation, and resorption can be influenced depending on the individual's resistance. Prosthetic factors relate to the type and materials of the prosthetic constructions and the principles on which they operate (9).

Postextraction resorption is more pronounced on the buccal plate of the socket for both jaws since the plate is thinner than the lingual one and often consists mainly of bundle bone. This process eventually can lead to buccal dehiscences and fenestrations (10).

Postextraction alveolar bone loss cannot be prevented but can be limited by appropriate ridge preservation techniques. Factors affecting the resorption process are of extreme clinical importance. Some authors divide them into systemic and local factors. The systemic factors include comorbidity (uncontrolled diabetes mellitus, bone metabolic disorders) and some harmful habits, such as smoking. Patient compliance is also of extreme importance. Local factors are the amount and extent of surgical trauma, number of extracted teeth, morphological features of the socket (number, wall thickness, presence of fenestrations and dehiscences, bone density, and so on), presence of infection of endodontic or periodontal origin, type and position of the tooth, periodontal biotype, type and time of prosthetic treatment, and so on (11–14).

Of the listed above, it has been suggested that the condition of the postextraction socket is of the greatest importance. According to studies by Ferrus

et al. (15) and Tomasi et al. (16), the width of the buccal plate significantly affects the resorption pattern.

According to several studies, surgical trauma, including the elevation of mucoperiosteal flaps, enhances osteoclast activity and may lead to external resorption of the crest (17–19). The average bone loss after a mucoperiosteal flap preparation is between 0.4 and 0.8 mm. This resorption is also observed when partial-thickness flaps are used, but not to such an extent (20, 21).

It has been reported that atraumatic tooth extraction might play an important role in preserving tissue volume (22).

Another factor affecting ridge resorption is the periodontal status. Lee et al. (23) investigated the application of ridge preservation after extraction of teeth affected by periodontal disease. Only 0.8% of the preserved sockets lacked bone volume sufficient for implant placement compared to the control group where this percentage was 4.7%.

The harmful influence of smoking on the general health and function of various systems is well-known. It has numerous side effects on the skeletal system, such as a difficult healing process, increased bone resorption at fracture lines, and impaired osteoblast function.

Bone loss in smokers was found to be 2.7 times greater than in non-smokers. In addition, smoking slows down healing processes after surgical interventions in the oral cavity. It is associated with loss in alveolar crest height, increased bone resorption, and a greater incidence of periodontal disease (24). Furthermore, smoking is associated with a greater risk of tooth loss, failure of implant treatment, and adverse effects on the level of peri-implant marginal bone (25–27).

The impact of smoking on periodontal health is well-documented (28, 29). It has been associated with an increased incidence of poor periodontal health (30), greater vertical bone loss (31), and peri-implant marginal bone loss (32). Smoking can modulate the expression of osteogenic and inflammatory factors in the alveolar bone (33).

Smoking can significantly affect the healing processes in the postextraction sockets, the exact mechanisms for which are not fully understood, but the main role is attributed to the nicotine content.

It is also associated with reduced width and radiographic density of postextraction sockets 6 months after extraction (24). However, it is not clear whether it interferes with bone regeneration in the socket or induces changes in the structure of the extracellular matrix, e.g., disturbances in the mineral phase, changes in the secondary structure of collagen, and atypical variations in the mineral content.

Saldanha et al. investigated the effect of smoking on the remodeling processes of the alveolar crest after tooth extraction (24). Intergroup analysis showed no statistically significant difference in alveolar ridge height and width, and radiographic bone density at the center of the socket in smokers and non-smokers. However, a significantly lower density at the apical part of the sockets was registered in the smoking group. Although a statistically significant loss in alveolar crest height was reported in both groups 6 months after the extractions, a statistically significant reduction in crest width and radiological bone density in the apical parts of the sockets was found only in the smoking group. Therefore, smoking can be considered a factor affecting the remodeling processes after tooth extraction, leading to more pronounced volumetric changes in the alveolar crest and a delayed healing process.

Another factor influencing the extent of postextraction resorption is the tooth region. It has been suggested that the process of postextraction resorption is more prevalent in the molar region compared to the premolar region, as well as in the lower jaw compared to the upper jaw (34). Accordingly, it has been reported that the resorption in the lower jaw can be up to four times faster than that of the upper jaw (5).

It is widely believed that horizontal resorption is more pronounced at molar sites, while the vertical loss of the buccal plate is more pronounced at non-molar sites.

As for the socket walls, some authors suggest that vertical bone loss is more prevalent at the buccal plate (35), which is due to its thin wall, made up mainly of *bundle bone*—a tooth-dependent structure, consisting of lamellar bone, and with a thickness of 0.2–0.4 mm (6, 36).

Buccal bone width of less than 1 mm has been associated with a greater degree of postextraction re-

sorption because it is composed mainly of cancellous bone (37).

It has been reported that the width of the buccal plate affects the rate of bone resorption. (38). Bone volume loss in sockets with thin bone walls (≤ 1 mm) can be up to three times greater than in sockets with thicker bone plates (> 1 mm) (39).

Chappuis et al. (40) examined on CBCT the postextraction changes of the buccal bone plates in the anterior areas of the dentition over 2 months and found that a plate width ≤ 1 mm was a critical factor for a greater degree of resorption. In these cases, they described a vertical loss of 7.5 mm (62.3%) compared to that for thicker walls—1.1 mm (9.1%), i.e., the vertical resorption reported by them was 3.5 times greater than that reported by other authors. Regarding horizontal resorption, the authors found that for walls ≤ 1 mm it was 0.8 mm, while for walls > 1 mm they did not observe such.

Further research is necessary to determine how the knowledge of the factors influencing postextraction resorption can be used as a predictive factor for the expected amount of bone loss, and the exact methods that can prevent such resorption, such as ridge preservation, immediate implant placement, etc.

CONCLUSION

Postextraction alveolar ridge resorption is an inevitable process that can hinder the implant and prosthetic rehabilitation of the dentition. Numerous systemic and local factors, such as the extent of surgical trauma, morphological features of the socket, presence of infection, type and position of the tooth, periodontal biotype, type and time of prosthetic treatment, and some metabolic disorders and bad habits, such as smoking influence it. Further research is necessary to determine how postextraction bone loss can be predicted and prevented to some extent.

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