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Review

Strategies for alveolar ridge reconstruction and preservation for implant therapy



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ABSTRACT

Purpose: In dental implant treatment, ridge preservation and immediate or early implant placement are recommended to minimize bone resorption after tooth extraction and achieve esthetic outcomes. However, there is no consensus concerning the efficacy of this surgical method. There is also no consensus on the efficacy of bone and soft tissue grafts and surgical methods for alveolar ridge reconstruction.

Study selection: This paper reports ridge alteration in the anterior maxilla after tooth extraction, and summarizes the efficacy of various ridge preservation methods and immediate or early implant placement as alveolar ridge preservation methods to minimize bone resorption after tooth extraction. The advantages and complications of alveolar ridge reconstruction methods, and the efficacy and surgical method of soft tissue graft are reviewed.

Results: The anterior maxilla is in the esthetic zone, and the thickness of the bone on the labial side around the natural tooth is less than 1 mm in many cases. Therefore, it is impossible to prevent bone resorption completely, even if ridge preservation and immediate or early implant placement are performed after tooth extraction. It is necessary to obtain stable and long-term esthetics by combining connective tissue and free gingival grafts, in addition to hard tissue augmentation.

Conclusions: It is important to consider the burden and level of satisfaction of patients, such as in terms of donor site morbidity in hard and soft tissue grafting, and to pay attention to appropriate indications to avoid overtreatment.

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1. Introduction

Successful implant treatment involves not only obtaining osseointegration but also placing a prosthesis with long-term stability and good esthetic results, function, and cleaning property. Although a horizontal bone width on the labial side of more than 2 mm and sufficient gingival thickness are considered ideal for a prosthesis with good esthetic results, the volume of the hard and soft tissues is often insufficient due to the ridge alteration after tooth extraction; an approach to overcome this issue is eagerly anticipated.

Socket preservation and immediate or early implant placement are recommended to minimize bone resorption after tooth extraction. However, there is no consensus concerning the efficacy of this surgical method. For hard tissue reconstruction, block bone graft using autogenous bone, guided bone regeneration (GBR), and distraction methods have been applied as vertical and horizontal bone augmentation. However, considering that these methods require surgical invasion and are associated with the risk of complications such as infection, they are not appropriate in all cases. For soft tissue, free gingival graft (FGG) and connective tissue graft (CTG) were combined to increase the soft tissue, and results with long-term stability were obtained. However, considering the burden and level of satisfaction of patients, these methods cannot be applied to all cases. Case selection criteria should thus be established to avoid overtreatment.

The aim of the present review is to clarify whether socket preservation and immediate implant placement are effective as an alveolar ridge preservation method, and to investigate the latest evidence on various strategies of alveolar ridge reconstruction, and application criteria and the surgical method of soft tissue graft.

2. Ridge alterations following tooth extraction

A key prerequisite for esthetic outcomes in the anterior maxilla is adequate bone volume, including a facial bone wall of sufficient thickness and height [1,2]. Therefore, it is extremely important to understand ridge alteration after tooth extraction for implant treatment in the esthetic zone. An experimental study on canine mandibular premolar sites was performed to evaluate bone resorption after tooth extraction, and a change in the facial bone in the extraction

socket at 8 weeks after tooth extraction was observed. The result showed 2.2 mm vertical resorption of the facial bone wall in the mid-facial area [3]. These changes start with bundle bone resorption adjacent to the periodontal ligament, into which Sharpey fibers are inserted. Tan et al. reviewed alveolar ridge alteration in humans up to 12 months after tooth extraction [4]. This systematic review demonstrated that horizontal reduction (3.79 mm) was greater than vertical reduction (1.24 mm at buccal, 0.84 mm at mesial, and 0.8 mm at distal sites) at 6 months. The horizontal bone resorption change was 29–63% and the vertical change was 11–12% at 6 months [4]. Factors affecting dimensional change after tooth extraction include a flap or flapless status [5,6], smoking [7], single-rooted tooth or multiple-rooted tooth [8], and immediate denture [9]. In contrast, a study on three-dimensional ridge alteration in the esthetic zone after tooth extraction using CBCT showed that the median vertical bone loss in the central sites of the buccal bone wall was 5.2 mm (48.3%) at 8 weeks after tooth extraction, and the median horizontal bone loss was 0.3 mm (3.8%), suggesting larger vertical bone resorption. In the thick-wall phenotypes where facial bone wall thickness is more than 1 mm, vertical median bone loss was 1.1 mm. In contrast, in the thin-wall phenotypes where facial bone wall thickness was less than 1 mm, vertical median bone loss was approximately 7.5 mm [10]. These results suggested that vertical bone loss was 3.5 times more severe than findings reported in a canine model when the facial bone thickness was less than 1 mm. Especially in the esthetic zone, it was shown to be rare for facial bone wall thickness to be more than 1 mm [11]. In a study on facial bone wall thickness of the anterior maxilla, where the distance from apical region to the CEJ was 4 mm, as measured in 125 subjects using CBCT, median facial bone wall thickness was 0.47 mm in central incisors, 0.54 mm in lateral incisors, 0.45 mm in canines, and 0.73 mm in first premolars, suggesting that facial bone wall thickness was less than 1 mm in all areas. The proportions with more than 1 mm bone wall thickness were 4.6% in central incisors, 11.5% in lateral incisors, 8.6% in canines, and 27.5% in first premolars. These results showed that more than 1 mm bone wall thickness was noted in only about 25%, even in first premolars, where the labial bone was the thickest [12]. Since facial bone was thin, and surrounding bone mostly consisted of bundle bone, vertical bone resorption after tooth extraction was more severe in the esthetic zone (Fig. 1). Ridge preservation, immediate or early loading, and reconstruction of the hard and soft tissues need to be considered to avoid ridge resorption for esthetic implant treatment (Fig. 2).

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