International Journal of Dental Sciences
www.dentaljournal.in
E-ISSN: 2663-4708
Received: 29-11-2025; Accepted: 28-12-2025; Published: 12-01-2026
Volume 8, Issue 1, 2026, Page No. 8-10

Surgically assisted orthodontic space closure of atrophic alveolar ridge in the mandible: A narrative review

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Abstract
In adults, closing an old extraction site with bone defects is challenging for orthodontists. After several years following extraction, bone remodeling produces a buccolingually narrowed alveolar process, and closure of the extraction spaces requires reshaping of the cortical bone. Moreover, malocclusions in adults may be complicated by the migration of adjacent teeth at old extraction sites. Under these circumstances, functional and esthetic results may only be achieved with a combination of surgery, orthodontics, and prosthodontic rehabilitation. This article reviews various surgical procedures, such as the split-crest technique, periodontal accelerated osteogenic orthodontics, distraction osteogenesis, and ridge preservation, which facilitate orthodontic space closure of the atrophic ridge.

Keywords: Atrophic ridge, split crest technique, corticotomy, distraction osteogenesis, ridge preservation

Introduction

A common clinical finding in adult orthodontic patients is posterior spacing due to missing mandibular teeth. Excluding the third molars, the mandibular second premolar is the most common congenitally absent teeth while the mandibular first molar is the most frequently lost tooth in adults [1-3]. When the first molar was lost, the second molar usually tips mesially and the second premolar drifts distally, altered gingival form and constriction of the edentulous ridge [4-9]. After extraction of the mandibular first molar, the alveolar process of the jaws starts to atrophy because loss of bucco-lingual cortical plate, clot retraction, resorption of alveolar bone during the healing process or mastication impairment [6, 10-11]. Displacement of teeth into substantial atrophy of the alveolar ridge has considered a major limitation, especially in the posterior part of the mandibular arch, because of predominantly cortical bone, less trabecular bone, less cellular, less vascular and the mandibular molar roots are extremely wide buccolingually [12-13].

Under most circumstances, there are three clinical options for the management of a missing mandibular first molar. They include alignment of abutment teeth as needed, followed by placement of a fixed partial denture, fabrication of an implant-supported crown as a single tooth replacement, and orthodontic space closure. Disadvantage of a fixed partial denture and implant supported crown are mean life span often 10 to 15 years, increases risk of caries, periodontal disease, damage to health teeth and high cost [10].

Mesial movement of mandibular second molar to close the mandibular first molar extraction space was limited by the rate of cortical bone remodeling which about 0.5mm/month [14]. Moreover, mandibular second molar protraction through the atrophic first molar extraction site took the risks including root resorption, dehiscence, fenestration, loss of alveolar bone support, anchorage loss, devitalization and absence of new bone formation [4].

The rate of resorption is greatest during the first several months to two years after extraction, but decreases thereafter. The amount of post-extraction resorption was significantly greater on the buccal side than on the lingual side in both arches. During the first year of tooth extraction, the amount of resorption in the mandible is twice that in the maxilla, a ratio that increases to 4:1 after seven years.

The adult patient resists the formation of new bone during movement into a narrower edentulous space. The ideal dimensions reported for a successful mandibular first molar space closure was reported to be 6mm or less of mesiodistal space and 7 mm of buccolingual width [2, 3].

Alveolar crest augmentation is usually required when inadequate bone width limits orthodontic space closure [14]. Various bone-grafting materials have been used in alveolar bone grafting procedures. These materials include autogenous bone, allogenic bone, and bone graft substitutes. These grafts can be used alone or in combination with platelet-rich plasma to enhance bone formation and increase the rate of bone graft healing. The use of platelet rich plasma is based on the premise that the large numbers of platelets in platelet rich plasma release significant quantities of growth factors that may be promising for acceleration of bone regeneration [15-17]. This review provides a brief summary of the split-crest technique, periodontal accelerated osteogenic orthodontics, distraction osteogenesis, and ridge preservation, which facilitate orthodontic space closure of the atrophic ridge.

Split crest technique

Surgical and orthodontic therapies were combined to form rapid orthodontics after the ridge-splitting technique. This synergistic strategy offers two advantages for clinicians.

The first is to overcome the anatomical obstacle to orthodontic movement by surgically separating the lingual cortical plate from the buccal plate, opening a path wide enough to allow easier and faster tooth movement [20]. The second is to use the tissue regenerative potential of the periodontium in adjacent teeth to generate new bone and soft tissue through orthodontic movement. The presence of intact alveolar support and a healthy periodontium on the teeth adjacent to the atrophic area is a requirement for the successful application of this technique [22].

The split-crest technique was performed using piezosurgical instruments in the first molar edentulous area to widen the bone crest and open channels for tooth movement. Immediately after the surgical procedure, orthodontic appliances were used to move the second premolar distally and the second molar mesially into the surgical site. The rationale was to facilitate and accelerate orthodontic movement of the teeth, which is otherwise difficult in a cortical knife edge ridge [20-22].

Periodontal accelerated osteogenic orthodontics

Periodontal accelerated osteogenic orthodontics (PAOO) is a clinical procedure that combines selective alveolar corticotomy, particulate bone grafting, and orthodontic force application. This procedure is theoretically based on the bone healing pattern known as the regional acceleratory phenomenon [23-24]. PAOO results in an increase in alveolar bone width, shorter treatment time, increased posttreatment stability and decreased amount of apical root resorption [25-27].

Distraction osteogenesis

Modalities to augment horizontal and vertical bone defects include autogenous onlay bone grafting, guided bone regeneration, alloplastic augmentation, and alveolar split grafting. Each of these modalities has its own advantages and disadvantages. The use of an autogenous bone graft has donor site morbidity, and graft resorption is expected to occur. Although guided bone regeneration has been extensively documented, it is often difficult to provide optimal space for the regeneration of the desired bone volume and is therefore better suited for limited defects. Alloplastic materials used in large quantities are not reliable for implant osseointegration.

Alveolar widening by distraction osteogenesis is an alternative method for reconstructing alveolar atrophy, which is similar to alveolar split grafting but without the graft [17].

Ridge preservation

Socket grafting significantly reduces early bone loss. Bone replacement graft materials have played an important role in regenerative dentistry for several years now. The current concept of tooth extraction routinely considers the maintenance of the existing extraction socket dimensions with some sort of bone replacement material [28-30]. This procedure is called ridge preservation.

Conclusion

Difficulty in protracting the mandibular molar through the atrophic alveolar ridge in the mandible can be overcome by combining surgery and orthodontic treatment. This approach restores periodontal status, increases the rate of tooth movement, and decreases treatment duration, especially in adults.

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