Journal of Chemical Health Risks

www.jchr.org

JCHR (2026) 16(2), 1871-1877 | ISSN:2251-6727

Pre-Prosthetic Surgery: A Review

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(Received: 16 January 2026 Revised: 25 February 2026 Accepted: 17 March 2026)

KEYWORDS

Pre-prosthetic surgery, alveoloplasty, vestibuloplasty, ridge augmentation, frenectomy, tori,

ABSTRACT:

In cases where teeth are missing or merely partially missing, oral tissues have to be surgically prepared to receive a prosthetic rehabilitation process referred to as pre-prosthetic surgery. This progressive and irreversible loss of alveolar bone following the loss of teeth results in the inefficiency of hard and soft tissues, which consequently result in the failure of the retention, stability, and comfort of prostheses. This review follows the historical evolution and clinical justification of pre-prosthetic surgery interventions - starting with ancient methods of alveoloplasty and current methods of vestibuloplasty, ridge augmentation, torus removal, frenectomy, and tissue engineering. The literature confirms that while dental implants have modified the scope of pre-prosthetic procedures, the foundational surgical techniques remain indispensable for a significant proportion of patients requiring conventional or implant-supported prostheses.

1. Introduction

The gums and bone that surround the jaws are an ideal fit for dental prosthesis, which also need to be adaptable to the dynamic mouth. The quality of the denture's construction is irrelevant if it can't compensate for the constraints of the supporting structure. The evolutionary masticatory system, optimally efficient with natural teeth, was not designed for the biomechanical demands of complete denture wearers, and this disparity underlies the entire discipline of pre-prosthetic surgery.[1,2]

Why is a full denture the only dental repair that the mouth is naturally suited for? This is a basic question that has been asked for a long time. Prior to prosthesis fabrication, a thorough evaluation of the hard and soft tissues that will be supporting the denture must be conducted. In many patients, ideal prosthetic treatment is impossible without first surgically restoring the oral

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www.jchr.org
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tissues — these procedures collectively constitute pre-prosthetic surgery.[3-5]

From minor dento-alveolar irregularity correction, exostoses, and hyperplastic tissue removal to vestibular sulcus extension treatments, substantial augmentation surgery, and now the age of verified osseointegrated implants, pre-prosthetic surgery has come a long way. There are a number of variables, including those related to anatomy, metabolism, function, and prosthesis, that contribute to the progressive resorption of residual alveolar ridges. The need for mandibular pre-prosthetic intervention is higher than in the maxilla because alveolar bone loss in the mandible occurs at a rate that is about four times higher.[6-8]

This review synthesizes the chronological development, clinical indications, procedural classifications, and contemporary relevance of pre-prosthetic surgery.

2. Review of Literature

Early Foundations (1853–1952)

The earliest documented pre-prosthetic intervention is attributed to Willard (1853),[1] is said to have been the first American dentist to reduce the space between teeth and the gums and the edges of the jawbone after extractions, allowing for the earlier creation of dentures. In 1876, Beers[2] subsequently advocated systematic excision of alveolar bone when the alveolar process was unnaturally prominent after tooth removal.

Dean et al. (1922)[3] provided one of the earliest systematic frameworks for surgical preparation of the denture-bearing area, emphasizing that surgical measures should produce a smooth, full, round ridge with parallel sides, and that intraseptal alveolotomy offered advantages when performed by a trained operator. Molt (1923)[4] established partial alveolectomy as a definitive operative procedure arising naturally from increasing scientific attention to denture construction.

Kazanjian (1924)[5] was the first to use a labial flap pedicled off the alveolar process to cover the bone surface throughout the healing phase of the flap. This provided an additional tooth-bearing area and this resulted in making the procedure more stable. One more time, ten years later, Kazanjian (1935)6 explained that surgery is indispensable to an effective denture adaptation where the abnormal mouth conditions are beyond the mechanical ability of the dentist.

A proper denture foundation has 3 critical needs, which Godwin (1947)7 established and they included the bony base, the mucoperiosteum, and the mucoperiosteum immobility. He inferred that the aim of submucous surgery is to yield a smooth bony base with adequate submucous tissue giving minimal resiliency and lack of mobility. Trauner (1952)8 discussed the unsavoury mandibular states by proposing alveoloplasty coupled with lingual ridge extensions as a remedy to reduce the denture retention.

Advancing the Field (1953–1975)

Clark (1953)[9] solved by the flap pedicle running in a opposite direction on Kazanjian, to the lip, instead of the alveolar process, and keeping the shallow vestibule issue under control, but avoiding the more severe scarring and loss of lip mobility of the original one. Gillies (1956) highlighted the prominent mylohyoid ridge as a frequent cause of painful denture irritation in the posterior mandible, and advised this to be cut back any time it is detected at the level or above the alveolar process.

Atwood (1962) added a pioneering study of the residual ridge resorption rate which has become multifactorial in nature and clinically significant in the pre-prosthetic planning procedure. Obwegeser (1963) took a major step in augmenting the procedure of vestibuloplasty by integrating skin graft vestibuloplasty as well as floor-of-mouth lowering with coordinated articulation of lingual and buccal sulcus deepening. Tortorelli (1968) improved the techniques in the mandibular labial sulcus-deepening, the cumbersome dressings were eliminated, and an increase in the depth of the vestibular was predictable, and functional preservation of the facial muscles occurred.

A 25-year long-term study published by Tallgren (1972), indicated that residual alveolar ridges in complete denture wearers were reduced in progressively diminishing rates, which proved that the mandible resorbs at four times the maxillar rate.

Ridge Augmentation and Classification (1975–1994)

Bell et al. (1978)[15,16] introduced two new augmentation procedures that add a new dimension to the treatment of

Journal of Chemical Health Risks
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JCHR (2026) 16(2), 1871-1877 | ISSN:2251-6727

severe alveolar atrophy: inferior repositioning of the atrophic mandibular ridge by horizontal osteotomy with simultaneous bone grafting and superior repositioning of the atrophic maxillary edentulous ridge by LeFort I osteotomy.

Mercier and Lafontant (1979)[17] described the general resorptive changes of an edentulous ridge in four stages: a wide crest accommodating recently extracted teeth; a thin, pointed ridge; a flattened crest at basal bone level; and finally, concavity as basal bone resorbs. Cawood and Howell (1988)[18] published their landmark classification of the edentulous jaws into six classes, from Class I (dentate) through Class VI (extensive basal bone loss), providing a universally adopted anatomical framework for pre-prosthetic and pre-implant planning.

Hillerup (1994)[19] specifically addressed preprosthetic surgery in the elderly, concluding that the discipline remains a relevant treatment option when appropriately tailored to individual patient needs, and that the combination of preprosthetic surgery and implants can solve problems that neither modality can address independently. He also stressed that interdisciplinary cooperation is a prerequisite for optimal outcomes.

Contemporary Contributions (2009–2016)

Cillo and Finn (2009)[20] shown that patients with shallow mandibular vestibules may benefit from a combination of split-thickness skin graft vestibuloplasty and mandibular endosseous implant insertion, which successfully prepares the edentulous mandible for implant-supported overdentures.

Bouchard et al. (2014)[21] presented a new method for treating severe maxillary atrophy: palatal osteotomy in conjunction with vestibuloplasty. This procedure improves retention by amplifying the palatal suction effect, stops dentures from moving laterally and anteroposteriorly, and eliminates the need for a skin graft.

Ephros et al. (2015)[22] reiterated that every patient whose conventional prosthesis is planned for should have surgical improvement of anatomy addressed, as the need for preprosthetic surgery might be triggered by anatomical differences, progressive tissue loss, or a lack of foresight during earlier phases of therapy. According to Fahmy et al. (2016)[23] proposed that custom-designed three-dimensional bioprinted scaffolds incorporating polymers, ceramics, bioplastics, growth factors, and living cells could revolutionize preprosthetic surgeries, offering patient-specific designs capable of preventing micromobility and improving vascularization.

3. Goals and Objectives of Pre-Prosthetic Surgery

Prior to prosthetic surgery, the mouth is prepared in order to eliminate illness and create structural and functional changes that will accommodate the needs of full denture wearers. The specific goals of the procedure are as follows: creating a wide, level ridge that is at least 5 mm tall and surrounded by bony walls that are nearly parallel and not cut; creating a strong, resilient mucosal covering with buccal and lingual sulci that are not interrupted by frena, scars, or extra tissue; making sure that there is at least 16-18 mm of space between the arches to accommodate prosthetic components; creating the proper antero-posterior, transverse, and vertical relationships between the jaws; and ensuring that there is enough bone form and tissue coverage for the placement of implants.

Six criteria define the surgical targets that pre-prosthetic procedures aim to achieve: proper prosthesis insertion, correct occlusal vertical dimension, patient comfort, adequate retention, denture stability with satisfactory occlusion and appearance, and absence of tissue damage.[22] Fulfilling these goals allows wide distribution of functional forces, thereby reducing adverse bone and soft tissue changes.

4. Resorptive Patterns of the Edentulous Ridge

There are physiologic, environmental, and pathologic factors that contribute to ridge resorption after tooth extraction; it is a cumulative, chronic, progressive, and irreversible process.[11] Wolff's law explains that bone adapts its mass and structure to mechanical demands; once teeth are lost, the absence of functional stimulation through the periodontal ligament results in disuse atrophy of the alveolar bone.[24,25]

The resorptive process differs in pattern between the maxilla and mandible and between anterior and posterior sites.[14,17] Bone loss in the maxilla happens in both vertical and horizontal directions, but in the mandible it's more vertical and posterior. An altered periosteal blood supply, perhaps transitioning from a centrifugal arterial to a diminished centripetal periosteal supply, makes the mandible even more prone to

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www.jchr.org
JCHR (2026) 16(2), 1871-1877 | ISSN:2251-6727

increased resorption as it ages. One of the main causes of pre-senile mandibular atrophy is this reduced supply, which may be caused by atherosclerotic alterations.[24]

The Cawood and Howell classification[18] stratifies residual ridge morphology into six classes: Dentate (Class I), post-extraction (Class II), convex (Class III), knife-edge (Class IV), flat ridge (Class V), alveolar process loss (Class VI), and basal bone loss (Class VI) are the six classes. Both methodical pre-implant surgery planning and surgical technique selection are based on this categorization.[24]

5. Hard Tissue Procedures

Alveoloplasty

In order to prepare for detachable prostheses or implant implantation, alveoloplasty involves trimming and removing labiobuccal alveolar bone, along with some interdental and interradicular bone. This procedure is done during or after tooth extraction.[3,4] Alveoloplasty, when done correctly, greatly lessens the likelihood of bony prominences, undercuts, and sharp ridges, which allows for the atraumatic insertion of dentures and the appropriate functioning of prosthetics.

The buccal cortical plate is incised toward the palate or lingual plate during intercortical alveoloplasty, which also entails removing interseptal bone. Especially when it comes to the front area, this method is perfect for fast denture implantation. To address situations of severe anterior overjet, Obwegeser's modification[12] moves the labial and palatal cortices."

Reduction of Bony Prominences

When the genial tubercles become too prominent due to severe anterior mandibular resorption to allow mandibular dentures to form an effective anterior lingual seal, the procedure of genial tubercle reduction may be recommended. Denture flanges pressing on the underlying mucosa due to mylohyoid ridge protrusion during alveolar resorption is a typical cause of posterior mandibular denture discomfort, which may be alleviated with reduction of this ridge. Muscle separation, bony contouring, ridge exposure, and primary closure are the steps in the technique.

When the intermaxillary space is invaded by an enlarged maxillary tuberosity, a decrease of the tuberosity is advised. At the intended vertical occlusion dimension, a minimum intermaxillary distance of 1 cm is necessary.

Tori and Exostoses

Tori are benign bony protrusions whose cause is unknown. Ori are important autogenous bone donor sites, according to the literature, and they prevent smooth denture placement in edentulous individuals. When they induce mucosal ulcers, severe undercuts, or psychological discomfort, they become obligatory targets for removal.

The lingual alveolus, specifically the premolar area above the mylohyoid attachment, is where you may find the mandibular tori. They have a complex origin that involves both hereditary factors and parafunctional behaviors, most notably bruxism. Possible complications of extensive mandibular tori include traumatic ulceration, difficulties with speaking and chewing, and obstructive sleep apnea. Careful subperiosteal elevation of the sensitive lingual mucosa is required for their reduction, followed by excision with a bur or a chisel.[22]

Ridge Augmentation

Ridge deficiencies have been classified into four classes that guide the selection of hydroxyapatite alone, hydroxyapatite combined with autogenous cancellous bone, or full combined reconstruction with autogenous bone. Augmentation becomes mandatory in severely atrophic ridges (Cawood and Howell Classes IV-VI)[18] because conventional vestibuloplasty alone does not provide sufficient and unsustained results.

"The mandibular height must be adequate to support the prosthesis, or the mental neurovascular bundle must be uncompressed, in which case rib grafts secured by interosseous wires are used for superior border augmentation. The benefit of inferior border augmentation is that it preserves the sulcus and makes future vestibuloplasty easier. It is used to treat heavily resorbed mandibles that are at danger of pathological fracture. The visor osteotomy raises the lingual cortex as a pedicled segment to increase ridge height while maintaining vascularity, and interpositional grafting puts bone between the parts of the mandible that have been osteotomized.[26]

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6. Soft Tissue Procedures

Vestibuloplasty

The purpose of a vestibuloplasty, a surgical procedure that involves repositioning of local tissues or grafting on the labial or lingual/palatal sides of the jaws, is to deepen the oral vestibule. The procedure also aims to provide mechanical resistance to displacement forces, create a stable area for dentures to be worn, and establish a strong foundation for overdentures, whether they are conventional or supported by implants.

Kazanjian technique[5], Godwin's method[7], Godwin's procedure[9], and the Edlan-type lip-switch procedure are all examples of secondary epithelialization techniques. These include an alveolar-pedicled flap with labial surface healing by secondary intention, a lip-pedicled flap with alveolar bone granulation, subperiosteal dissection with periosteum at vestibule depth, and a lip-pedicled flap with alveolar bone granulation. To reduce scarring and speed healing, Obwegeser's modification[12] uses a split-thickness skin graft (STSG) to cover the exposed bone.

An increased vestibular depth and keratinized epidermis on the denture-bearing mandible are consistently achieved with the well-established STSG vestibuloplasty. For patients with shallow vestibules, STSG vestibuloplasty, in conjunction with simultaneous implant insertion, may offer a solid base for implant-retained overdentures.[20]

When severe mandibular resorption causes mylohyoid-driven denture displacement, lingual vestibuloplasty with floor-of-mouth lowering is the recommended procedure. To address this, there are various techniques that can be used, such as crestal incision with muscle lowering, ridge smoothing, supraperiosteal access, or a combined approach that includes labial vestibuloplasty, submucous sulcoplasty, and bilateral mylohyoid ridge reduction all in one procedure.

Frenectomy

There are two methods for removing a prominent labial or lingual frena: a simple elliptical excision or z-plasty rearrangement. The latter method offers better predictability by reducing scar contracture; the former compromises denture stability and impairs peripheral seal.22 Midline fractures can occur as a result of deep notch requirements in the denture base. Denture displacement due to an attachment at the crest of the lingual ridge may need a lingual frenectomy, a procedure that involves diamond-shaped excision with or without genioglossus fiber sectioning.

Removal of Hyperplastic Tissue

Epulis fissuratum, most commonly found in the maxillary vestibule adjacent to ill-fitting dentures, is excised via supraperiosteal dissection with or without electrocautery.[22] The carbon dioxide laser has demonstrated efficacy as an alternative for such soft tissue excisions, offering reduced bleeding and wound contraction. Following excision, vestibular depth may be preserved using a maxillary soft-lined splint or STSG.

7. Bone Reconstruction in Pre-Implant Surgery

The introduction of osseointegrated implants has fundamentally enhanced the rehabilitation of partially dentate and edentulous patients. Successful implant placement depends on adequate bone volume in both height and width. A systematic pre-implant surgery scheme based on the six-class jaw classification[18] specifies augmentation requirements for each class of maxillary and mandibular atrophy.

Autogenous bone grafts — using particulate or block grafts from local sources (mandibular symphysis, ramus) or distant sources (posterior iliac crest, calvarium) — remain the gold standard for alveolar augmentation.[27] Local grafts from the mandibular ramus offer less donor morbidity and convenient access. Sinus floor augmentation[28] entails raising the sinus membrane to allow bone grafting for implant support in the posterior atrophic maxilla. Reducing morbidity and increasing corticocancellous bone availability, posterior iliac crest grafts are preferred over anterior iliac crest grafts for large defects.

Block grafts must be securely fastened with at least two fixation screws per segment to avoid micro-movement, which may compromise revascularization and lead to graft failure.[28] Particulate grafts — particularly cancellous bone with or without hydroxyapatite[26] — are preferred for sinus floor and contained defects due to faster healing. Cortical block grafts, while valuable for one-wall defects, require a longer healing time and

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JCHR (2026) 16(2), 1871-1877 | ISSN:2251-6727

carry greater infection risk during the extended period of non-vital bone presence.

8. Biomaterials and Tissue Engineering

Reconstruction of maxillofacial bone defects presents a major clinical challenge, particularly in ageing populations experiencing progressive jaw atrophy.[29] Autologous bone grafts impose significant donor site morbidity; biomaterials therefore represent an attractive therapeutic alternative.

Synthetic inorganic materials — principally hydroxyapatite (HA), beta-tricalcium phosphate (β-TCP), and biphasic ceramics — are the most widely used scaffolds for bone tissue engineering.[30] The efficacy of HA combined with autogenous cancellous bone for alveolar augmentation has been well documented.[26] While calcium phosphate ceramics are osteoconductive, they are not intrinsically osteoinductive and require biological signaling for de novo bone formation at ectopic sites.

Synthetic organic polymers, such as polyhydroxyacids (polylactides, polyglycolides) degrade by hydrolysis to non-toxic metabolites, and the rate of degradation can be adjusted by polymer composition and molecular weight. Collagen, fibrin, hyaluronan, alginate and chitosan are natural organic substances that react well with host cells, and are employed as scaffolds in the bone and soft tissue engineering processes.

Three-dimensional bioprinting which involves inclusion of polymers, ceramics, bio plastics, growth factors, and living cells in patient specific designs has shown much promise in transforming preprosthetic surgery by providing precision reconstruction avoiding micromobility, tension-free soft tissue closure and vascularization."

9. Conclusion

Pre-prosthetic surgery involves a continuum of well-thought and performed surgical procedures that maximize the oral preparation to prosthetic rehabilitation. Since the primitive alveoloplasty of the nineteenth century, all the way to the advanced augmentation, vestibuloplasty, and tissue engineering procedures of the twenty-first century, the field has undergone constant development following not only the emergence of new knowledge but also the implementation of new clinical requirements.

Although it is true that pre-implant hard and soft tissue preparation has become a new sign of phenomenal success of dental implants, the pre-prosthetic surgery remains a critical component of entire prosthodontic treatment. A large percentage of edentulous patients (especially the elderly, those systemically contraindicated to implants, or in the parts of the world where access to implants is limited) still wear conventional removable dentures and hence require the surgical preparation of best denture bearing tissues.

To achieve a good prosthesis the oral surgeon may have to work with the restorative dentist closely, careful pre-operative planning, and into depth knowledge of the anatomy of alveoli, resorption and biomaterials. With bioprinting and regenerative medicine still develop, the future of pre-prosthetic surgery is in an even more customized and bioactive reconstruction, so that the mouth is well primed with no matter what kind of prosthesis is being presented.

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