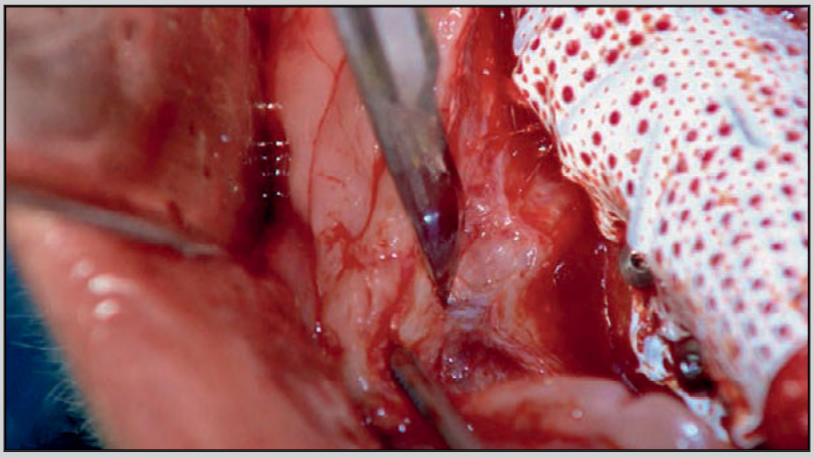
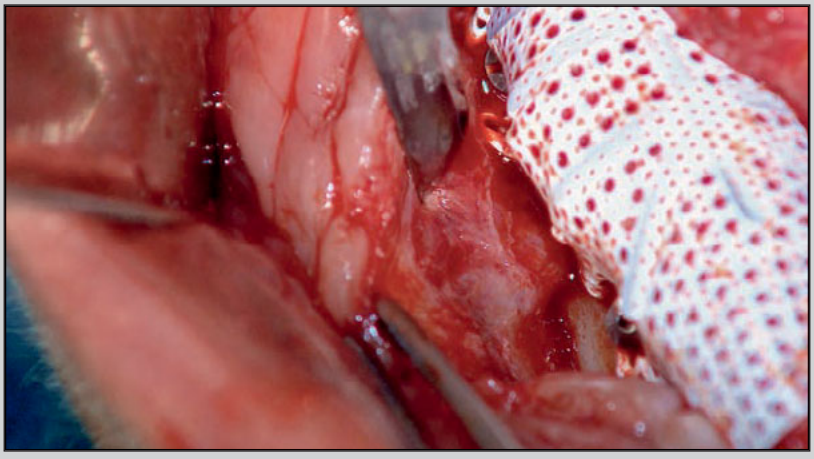
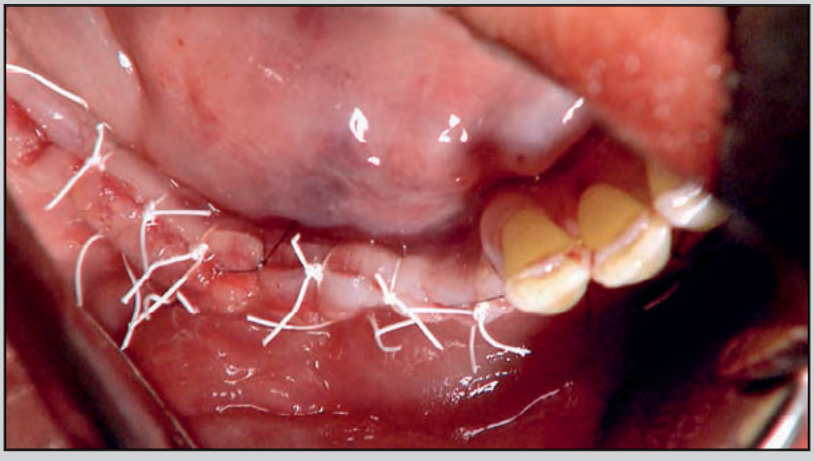
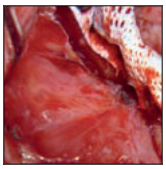






Periosteum Classification and Flap Advancement Techniques Around the Mental Foramen



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Various surgical flap advancement techniques for bone regeneration have been described in the literature; however, the clinical challenges of managing tissue that contains scars or embedded foreign materials have not been thoroughly described, especially around metal foramen. Fibrotic and thickened scar periosteum as well as mental foramen restrict the tissue from responding in the same way as native tissue. Therefore, additional considerations and approaches must be considered to achieve tension-free flap closure. This article presents a flap advancement classification that describes three common clinical scenarios based on the periosteum and soft tissue quality and provides surgical approaches for tissue management in each classification, with a focus on flap advancement around the mental foramen.
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The appropriate management of soft tissue is essential for flap advancement and is a key element for successful bone augmentation outcomes. Complications can occur, such as flap dehiscence due to inadequate flap advancement or postoperative paraesthesia caused by injury of the surrounding vital structures, like the mental nerve.[1,2] The quality and elasticity of soft tissue are significantly influenced by previous surgical interventions and must be considered when establishing the surgical plan and anticipated outcome. Understanding key anatomical structures and quality of the tissue are essential for planning successful flap manipulation, especially in the mental foraminal area. Therefore, this article highlights anatomical considerations around the mental foramen and proposes surgical techniques for buccal flap advancement based on a novel tissue classification that considers tissue quality in the surgical approach.

Surgical Management

Anatomy

The most critical area to protect during buccal flap advancement in the posterior mandible is the mental nerve. As the inferior alveolar nerve travels anteriorly in the mandibular

canal, it divides into the mental and incisal nerves in the molar region.[3] The mental nerve emerges facially from the mental foramen (MF) with three branches that innervate the skin of the chin, the skin and mucosa of the lower lip, and vestibular gingiva in the MF area.[4]

Incision Design

The incision design in the posterior mandible, independent of the amount of ridge deficiency, starts with a full-thickness crestal incision in the center of keratinized tissue, from the retromolar pad to the most distal tooth. An oblique vertical releasing incision is made distally and buccally within the retromolar pad area to protect the lingual nerve.[4] A safety distance of two teeth anterior to the grafted site mesiobuccally is preferred for the anterior releasing incision placement. A 3- to 4-mm releasing incision is recommended at the mesiolingual line angle of the most distal tooth to facilitate lingual flap advancement.[5]

Periosteal Scoring Incision

Periosteal scoring incisions (PSIs) close to the base of the mucoperiosteal flap facilitate flap advancement.[6] Identifying the location of the MF radiographically, preferably via CBCT, is the first step in avoiding trauma to the mental nerve bundles. The diameter, appearance, and location of the MF varies among races and genders and has been discussed in numerous investigations.[7–10] The MF can closely approximate the alveolar crest in a highly atrophic mandible.[11] As a result, it is necessary to recognize the available flap tissue around the MF by exposing the roof of the MF (with wet gauze), which is correlated to the amount of vertical height of the alveolar ridge. In a ridge with a minor vertical deficiency, the distance from the coronal margin of the buccal flap to the MF could be up to 15 mm. The authors of the present paper recommend a curved PSI around the MF, made as a dome-shaped incision with a coronal distance 6 to 8 mm away from the MF. To protect the mental nerve branches, the PSI should begin approximately 10 to 15 mm mesial and distal of the MF. In a highly resorbed ridge, the remaining soft tissue flap height above the MF is typically 6 to 7 mm, and the PSI in this scenario should be closer but maintain a distance of at least 3 mm from the MF. It has been recommended to coronally curve the periosteal incision to within 3 mm of the flap margin,[12] which is seen in the present guideline. Because the exact position of the mental nerve branches is unknown, careful dissection and gentle incision with a new blade is crucial.

Depth of Periosteal Scoring

The depth of periosteal scoring close to the MF should be as shallow as 0.5 mm, just enough to perforate the cellophane-like periosteum, which has an average histologic thickness of about 0.38 mm.[13] Microscopically, the periosteum is composed of two layers: a dense, outer, fibrous layer that provides mechanical stability, and an inner cambium layer that contains progenitor cells and collagenous fibers anchored to the bone. The incised periosteum exposes the connective tissue in the submucosa, allowing for blunt separation and elongation of the elastic fiber bundles. This maneuver can be done by rotating the blade 90 degrees and gently scraping through the elastic fiber bundles, followed by a pulling motion in a coronal direction using blunt periosteal instruments, such as a periosteal elevator. At the base of the flap, away from the MF, the PSI can be performed approximately 1 mm into the submucosa to achieve proper coronal advancement. When a significant advancement is needed, either a periosteal separation into the muscle layer or multiple scorings may be considered to obtain the desired flap release.[12]

Periosteum Classification

A mucoperiosteal flap with a native periosteum can easily be advanced 5 mm beyond the bone defect by utilizing two vertical releasing incisions with a PSI at the base of the entire flap[14]; however, a thickened fibrous tissue or scarred periosteum will limit the flexibility of the flap. While the literature provides techniques for tension-free flap advancement in the atrophic posterior mandible,[5,15,16] the surgical approaches described therein do not address the challenges when the tissue contains foreign materials or

Table 1 Periosteum Classification and Proposed Flap Management

Classification	Indication	Difficulty	Proposed flap management
Class I	Native periosteum with no scar tissue present	Easy	Periosteal scoring incision + periosteo-elastic technique (separation of elastic fibers).
Class II	Mildly fibrotic periosteum with the presence of scar tissue	Moderate	Periosteal incision through the fibrotic periosteum with more extensive debundling using a rotated blade (45 degrees) + periosteo-elastic technique. Alternative approach: Multiple periosteal scoring incisions + periosteo-elastic technique.
Class III	Thick, fibrotic, stone-like periosteum with pronounced scarring and foreign substances embedded	Difficult	Apical and coronal periosteal incisions around the foreign body incorporation. Partial/complete periosteoplasty/periosteal excision in between the periosteal incisions + periosteo-elastic technique. Care must be taken around the mental nerve.

scar tissue. The amount of flap flexibility (tension) within the tissue is attributed to the amount of elastic fibers, the thickness of the periosteum, and components of the extracellular matrix.[17] The periosteum and overlying submucosa have a different collagen fiber network after healing with scarring. The initial deposition of unorganized collagen fibers in early wound healing is replaced by dense, thicker, and more organized collagen fibers, which are correlated to the wound strength.[18]

Scarring within the periosteal and subperiosteal tissue is defined as a fibroproliferative response with accumulating "band-like" excess collagen fibers.[19] In extreme cases of disrupted wound healing, the damaged periosteum can form connective tissue–like calluses embedded with some nonabsorbent bone particles or titanium granules, thus completely losing flexibility.[20]

To overcome these surgical challenges, there is a need to classify the periosteum and soft tissue quality and propose techniques for each type of scenario. The proposed classification of flap advancement (Table 1) aims to identify the specific characteristics of soft tissue quality and the surgical techniques for suzccessful flap release (see Appendix Fig 1, available in the online version of this article at quintpub.com/journals).

Class I: Native Periosteum

Class I refers to a native periosteum with no scar tissue formed within the soft tissue. These areas have no previous soft or hard tissue augmentation, history of trauma, or oral pathologies.

The flap release with a native periosteum can be performed in two steps, including PSI and separation of the elastic fibers. The PSI should be made apical to the mucogingival junction, perpendicular to the periosteum, and extended from the distal to the mesial aspect of the flap in one continuous motion. For the Class I periosteum, a gentle PSI incision is made no more than 1 mm deep, without going too deep into the connective tissue. After incising the periosteum, a periosteo-elastic technique is used to separate the elastic fibers through blunt dissection and elongation. A scalpel rotated 45 to 90 degrees is used to cut the subperiosteal bundles with a sweeping motion to facilitate flap mobility (debundling). Brushing or pulling in a coronal motion by periosteal instruments further separates the elastic fibers (Fig 1). Alternatively, stretching the scoring line with a hemostat or blunted scissor can be used, but it is not recommended around the MF. A second PSI can be made parallel to the initial incision (3 mm away) and in a more coronal position if more release is needed, but that usually is not required in the Class I periosteum. Lastly, the flap mobilization is tested by extending the buccal flap margin 3 to 5 mm