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Alveolar ridge preservation after tooth extraction: clinical protocols illustrated with two case reports

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Abstract

Introduction
Post-extraction bone resorption is a predictable physiological process, particularly affecting the alveolar ridge and posing a clinical challenge, especially in the esthetic zone. These dimensional changes may compromise implant placement and prosthetic outcomes. Alveolar ridge preservation has been proposed as a preventive approach to limit post-extraction atrophy and optimize pre-implant anatomical conditions.

Observation
Two clinical cases of alveolar ridge preservation following tooth extraction are presented. Atraumatic extraction techniques were performed to preserve hard and soft tissues. Socket management focused on blood clot stabilization and the use of biomaterials. Clinical and radiographic follow-up showed favorable healing and satisfactory preservation of ridge volume, enabling subsequent implant planning.

Discussion
Physiological remodeling after extraction leads to significant horizontal and vertical bone loss, particularly of the buccal plate. Alveolar ridge preservation has been shown to reduce these dimensional changes. The presented cases highlight the importance of atraumatic extraction, appropriate biomaterial selection, and careful surgical technique in achieving predictable outcomes. Although resorption cannot be completely prevented, its extent can be significantly minimized.

Conclusion
Alveolar ridge preservation is an effective method for reducing post-extraction bone loss and maintaining favorable conditions for implant placement. The reported cases support its role as a valuable component of implant-oriented treatment planning.

Keywords: Alveolar ridge preservation, Tooth extraction, Bone resorption, Dental implants.

Introduction

In the esthetic zone, tooth extraction represents a major clinical challenge when implant-supported rehabilitation is planned. It inevitably leads to alveolar bone resorption and soft tissue alterations that may compromise functional and esthetic outcomes. Therefore, treatment planning should begin prior to extraction. Therapeutic options include spontaneous socket healing, immediate implant placement, or alveolar ridge preservation, depending on clinical and anatomical conditions. Alveolar ridge preservation aims to limit post-extraction resorption and to optimize the recipient site for future implant placement. The objective of this report is to highlight the clinical relevance of this approach through the presentation of two case reports illustrating different clinical protocols of alveolar ridge preservation performed at the time of tooth extraction**.** [1].

Observation:

First case report:

A 35-year-old male patient, with no relevant medical history, presented to the dental medicine department with esthetic and functional discomfort related to tooth discoloration and gingival recession involving tooth 21.

Periapical radiography revealed the presence of a periapical lesion associated with tooth 21 (Fig.1). Cone-beam computed tomography (CBCT) analysis demonstrated a periapical radiolucent lesion associated with thinning of the buccal cortical plate and apical fenestration, while the palatal cortical plate remained relatively preserved. These findings indicated a high risk of buccal cortical fracture during extraction (Fig .2).

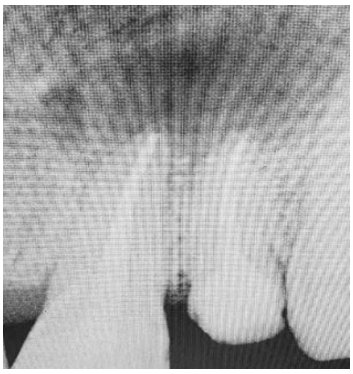


Figure 1: Periapical radiograph showing a periapical lesion associated with tooth 21

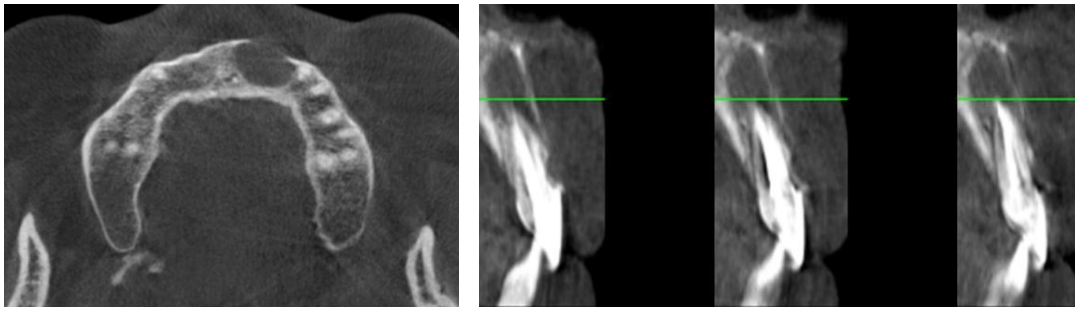


Figure 2: Axial and oblique coronal CBCT sections showing the periapical lesion with thinning and fenestration of the buccal cortical plate

The therapeutic decision consisted of atraumatic extraction of tooth 21 combined with cyst enucleation, followed by an alveolar ridge preservation procedure, with delayed implant placement planned to optimize esthetic and biological outcomes (Fig.3).

Figure 3: Atraumatic extraction and cyst enucleation followed by alveolar ridge preservation using and delayed implant placement

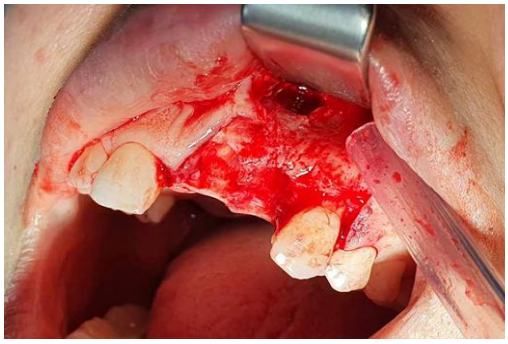


Figure 3a. Intraoperative views showing atraumatic tooth extraction followed by cyst enucleation with exposure of the buccal bone defect

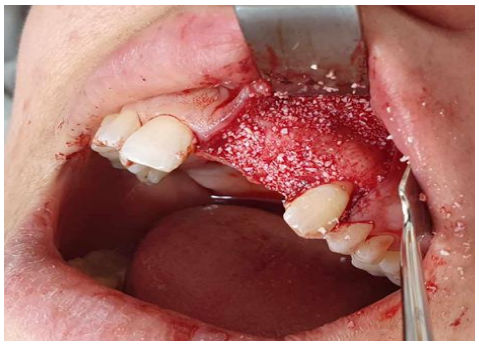


Figure 3b. Alveolar ridge preservation procedure with placement of bone graft material within the extraction socket

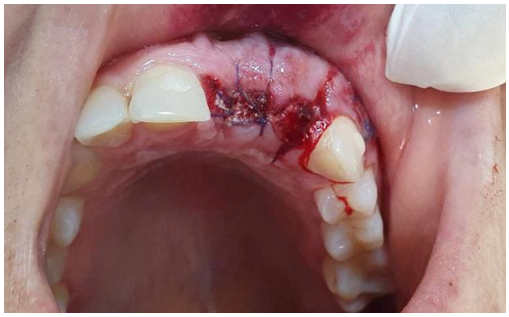


Figure 3c. Primary soft tissue closure after flap repositioning and suturing, allowing submerged healing prior to delayed implant

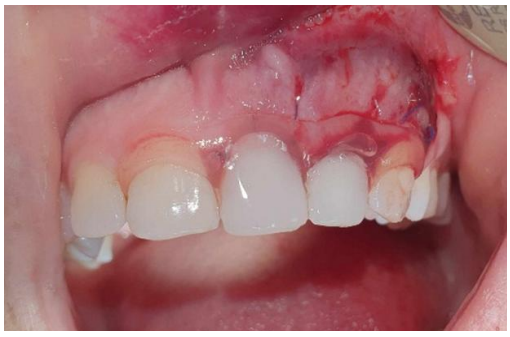
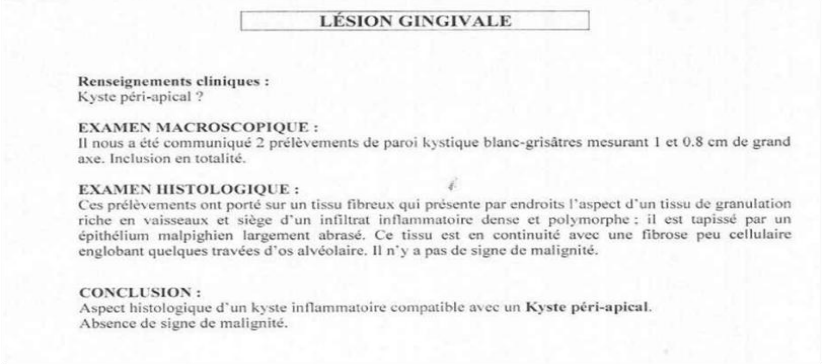


Figure 3d. Intraoral view showing placement of a provisional prosthesis at the treated anterior maxillary site

Histopathological examination of the surgical specimen confirmed the diagnosis of a periapical cyst.



LÉSION GINGIVALE

Renseignements cliniques :
Kyste péri-apical ?

EXAMEN MACROSCOPIQUE :
Il nous a été communiqué 2 prélèvements de paroi kystique blanc-grisâtres mesurant 1 et 0.8 cm de grand axe. Inclusion en totalité.

EXAMEN HISTOLOGIQUE :
Ces prélèvements ont porté sur un tissu fibreux qui présente par endroits l'aspect d'un tissu de granulation riche en vaisseaux et siège d'un infiltrat inflammatoire dense et polymorphe ; il est tapissé par un épithélium malpighien largement abrasé. Ce tissu est en continuité avec une fibrose peu cellulaire englobant quelques travées d'os alvéolaire. Il n'y a pas de signe de malignité.

CONCLUSION :
Aspect histologique d'un kyste inflammatoire compatible avec un **Kyste péri-apical**.
Absence de signe de malignité.

Figure4. Histopathological confirmation of periapical cyst

Post-preservation CBCT; made 6 months later; showed a well-preserved alveolar ridge with homogeneous bone fill of the extraction site and maintenance of the buccal cortical plate. The bone volume was stable and favorable for delayed implant placement (Fig.5).

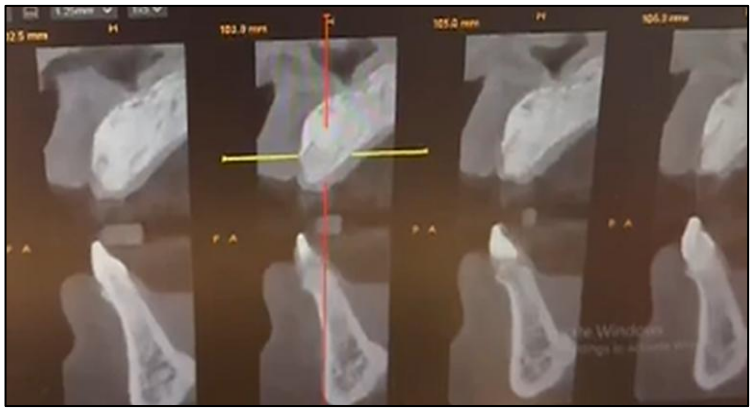


Figure 5: Post–alveolar ridge preservation CBCT showing homogeneous bone fill and preservation of the alveolar ridge

Second case report:

A 45-year-old male patient presented with pain and esthetic concerns localized to the anterior maxillary region.

CBCT analysis revealed two well-defined radiolucent lesions associated with teeth 11 and 21, along with buccal cortical plate disruption at site 11 (Fig.6).

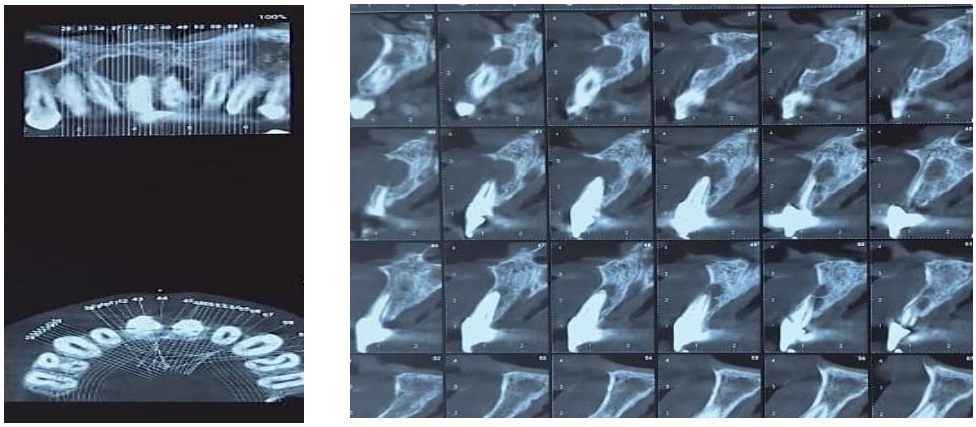


Figure 6: CBCT images showing two well-defined periapical radiolucent lesions associated with teeth 11 and 21

After local anesthesia, atraumatic extraction of the two teeth was performed in order to preserve the remaining hard and soft tissues as much as possible. A crestal incision was then made, followed by elevation of a full-thickness mucoperiosteal flap to allow adequate exposure of the surgical site. Intraoperative inspection revealed a rupture of the buccal cortical plate measuring approximately 2 cm, confirming the osseous extension of the periapical lesion.

Complete enucleation of the cystic lesion was carried out, along with careful curettage of the osseous walls. Following extraction and lesion removal, the post-extraction socket exhibited loss of the buccal bone wall, corresponding to a Type III extraction socket, which is considered a high-risk site for alveolar bone resorption and esthetic compromise.

Given these characteristics, an alveolar ridge preservation procedure was performed. The extraction site was filled with a bone graft material, followed by stabilisation of the site and flap closure with sutures, in preparation for delayed implant placement (Fig.7).

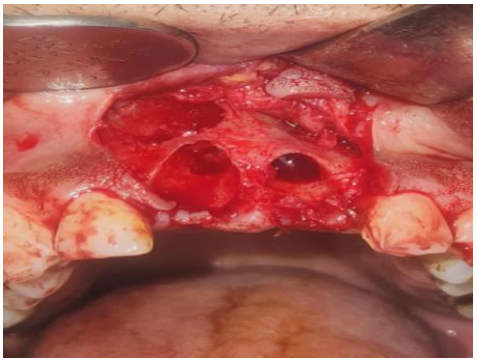


Figure 7: Intraoperative view after atraumatic extraction and enucleation of the lesions

Postoperative CBCT evaluation was performed 6 months later, it demonstrated homogeneous bone fill with restoration of the buccal cortical plate and preservation of alveolar volume, indicating favorable bone regeneration and optimal conditions for delayed implant placement at sites 11 and 21 (Fig.8).

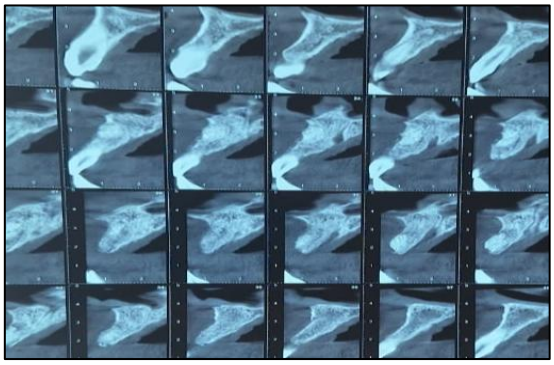


Figure 8: Post–alveolar ridge preservation CBCT demonstrating restoration of the buccal cortical plate

During a second surgical stage, a crestal incision with elevation of a full-thickness mucoperiosteal flap was performed, exposing the preserved anterior alveolar ridge. Two dental implants were placed at sites 11 and 21, with dimensions adapted to the available bone volume, and parallelism was carefully verified.

The implants achieved adequate primary stability, with an insertion torque of approximately 35 N·cm, allowing stable positioning at bone level. The occlusal view confirmed proper three-dimensional implant positioning, respecting the prosthetic axis and interdental spaces. The flap was then repositioned atraumatically and sutured (Fig. 9).

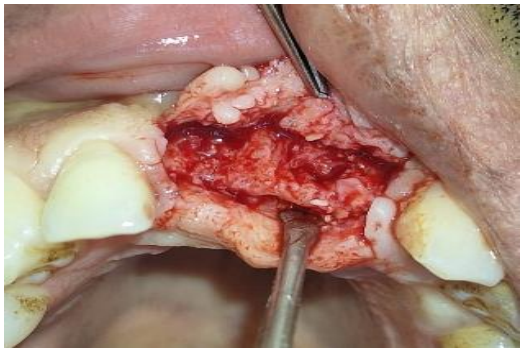


Figure 9a. Intraoperative view after crestal incision and elevation of a full-thickness mucoperiosteal flap, exposing the preserved anterior alveolar ridge

Figure 9b. Placement of two dental implants at sites 11 and 21 at bone level, with verification of implant positioning and parallelism

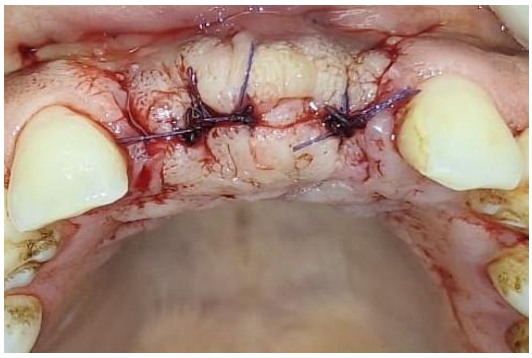


Figure 9c. Atraumatic flap repositioning and suturing following implant placement

Figure 9: Crestal incision, bone-level implant placement, and flap repositioning with sutures

Discussion:

Preservation of alveolar bone volume represents a fundamental prerequisite for achieving predictable functional and esthetic outcomes in implant dentistry. Following tooth extraction, physiological bone remodeling inevitably occurs, resulting in varying degrees of horizontal and vertical alveolar ridge resorption, particularly in the anterior maxilla. This post-extraction bone loss may compromise ideal implant positioning and increase the need for additional bone augmentation procedures [1].

In this context, contemporary implant treatment aims not only to replace the extracted tooth but, more importantly, to preserve the alveolar architecture from the earliest stages of care. After patient motivation toward optimal oral hygiene and adequate control of local and systemic risk factors, the first essential clinical step in managing a non-restorable tooth is the performance of an atraumatic extraction, regardless of whether immediate or delayed implant placement is planned. Minimizing trauma to the hard and soft tissues is critical to limiting post-extraction resorption and optimizing the biological conditions for implant success [1,4].

Atraumatic extraction therefore constitutes the first pillar of alveolar tissue preservation. It is defined as a procedure designed to remove the tooth while minimizing damage to the surrounding osseous and soft tissues, particularly the buccal cortical plate and the bundle bone, which play a key role in maintaining alveolar ridge volume. This approach relies on careful preoperative planning and the use of techniques adapted to root anatomy. For single-rooted teeth, severing the periodontal ligament fibers using periotomes or fine instruments allows gradual tooth mobilisation without the use of luxation forces as in the presented cases. For multi-rooted teeth, prior root separation is essential to convert a complex extraction into a

series of single-root extractions, thereby reducing mechanical stress on the alveolar walls [1,3].

The use of atraumatic devices, particularly ultrasonic instruments such as piezosurgery, further supports this tissue-preserving strategy. Piezosurgical systems enable precise, selective, and controlled bone cutting while preserving adjacent soft tissues, making them especially useful for root separation, periodontal ligament sectioning, and the management of impacted or ankylosed teeth. When combined with periotomes, piezosurgery facilitates progressive tooth mobilisation without the need for conventional elevators, whose levering forces may induce traumatic luxation, buccal plate fractures, and excessive bone loss. Likewise, bone drilling should be avoided whenever possible, with preference given to controlled tooth fragmentation and segmental removal. Collectively, these principles aim to preserve alveolar socket integrity, limit post-extraction ridge resorption, and optimize biological conditions for subsequent alveolar ridge preservation procedures and implant placement [1,2,3].

Beyond the extraction procedure itself, management of the post-extraction socket relies on a thorough, site-specific assessment to guide the most appropriate therapeutic decision. This evaluation should consider both hard and soft tissues, including the integrity and thickness of the residual alveolar bone walls—particularly the buccal plate—as well as the quality and volume of the peri-implant soft tissues and the periodontal biotype. These parameters are major determinants of post-extraction remodeling and esthetic outcomes, especially in the anterior region.

Several classification systems have been proposed to characterize extraction sockets according to the condition of the residual bone and soft tissues. Among them, the classification proposed by Elian and Cho which provides a clinically relevant framework for estimating the risk of post-extraction ridge collapse and for guiding treatment selection. According to this classification, Type II sockets are characterized by a partial loss of the facial bone plate in the presence of intact soft tissues, and are associated with an increased risk of post-extraction resorption. Both clinical cases presented in this report corresponded to Type II extraction sockets, for which spontaneous healing alone is often insufficient to preserve alveolar ridge dimensions, thereby justifying the indication for alveolar ridge preservation procedures [1,3,5].

Consequently, the choice between spontaneous healing, alveolar ridge preservation, or immediate, early, or delayed implant placement should not be based on a standardized protocol but rather on an individualized, site-specific approach. In extraction sockets considered at high risk for pronounced post-extraction remodeling, alveolar ridge preservation represents a predictable and biologically sound strategy to limit dimensional changes and optimize conditions for subsequent implant placement. In this regard, the systematic review and meta-analysis by Gustavo Avila-Ortiz et al.

(2019), comparing extraction sites treated with alveolar ridge preservation to those left to spontaneous healing, demonstrated a significant reduction in post-extraction bone loss, with an overall decrease in ridge resorption of approximately 46%, a mean preservation of bucco-lingual ridge width of 1.89 mm, and a maintenance of buccal ridge height of 2.07 mm. These dimensional benefits are particularly relevant in the anterior maxilla, where horizontal and vertical ridge resorption may compromise implant positioning and esthetic outcomes. By limiting ridge collapse, alveolar ridge preservation contributes to simplifying subsequent implant placement and reducing the need for more extensive augmentation procedures, thereby improving the overall predictability of implant rehabilitation [6].

Alveolar ridge preservation (ARP) has been shown to be effective in attenuating the dimensional reduction of the alveolar ridge that typically follows tooth extraction. However, its indication should not be considered systematic and must be based on a careful, site-specific assessment. ARP is particularly indicated in situations associated with a high risk of post-extraction remodeling, such as the presence of a thin or partially missing buccal plate, a thin periodontal biotype, extensive periapical pathology, or in esthetically demanding areas, especially the anterior maxilla. Conversely, extraction sockets with intact bone walls located in posterior regions with limited esthetic requirements may heal satisfactorily without the need for ridge preservation procedures [1,2].

Alveolar ridge preservation techniques rely on a wide range of biomaterials and biological approaches, the selection of which should be guided by the specific characteristics of the extraction site. Bone grafting materials include xenografts, allografts, and alloplastic materials such as β-tricalcium phosphate (β-TCP), which may be used alone or in combination. Site protection and space maintenance are commonly achieved through the use of barrier membranes, either resorbable—mainly collagen-based—or non-resorbable, in accordance with the principles of guided bone regeneration (GBR). In the first clinical case presented, alveolar ridge preservation was performed using a GBR approach combining a xenograft and a resorbable collagen membrane. Collagen sponges may be employed to stabilize the blood clot, while platelet-derived products can enhance the local biological environment through the release of growth factors. Emerging strategies in tissue engineering, including the use of stem cells, have also been investigated, although their routine clinical application remains limited. Regardless of the materials used, successful alveolar ridge preservation requires strict adherence to GBR principles, including clot stabilization, space maintenance, exclusion of soft-tissue ingrowth, and adequate wound closure [3,4].

Despite the documented benefits of ARP, its clinical value remains a subject of debate. Some authors have questioned whether ridge preservation offers a clear advantage over extraction alone in all clinical situations. For example, Adams, in a

2022 review published in the British Dental Journal, highlighted several potential drawbacks associated with ARP. These include reduced new bone formation in sites grafted with xenogeneic or allogeneic materials compared with spontaneous healing, the persistence of residual graft particles or granulation tissue, and the fact that ridge preservation does not consistently eliminate the need for subsequent bone augmentation procedures at implant placement. Additionally, ARP protocols may be associated with prolonged treatment times, often exceeding six months before definitive implant placement [7,2] .

Ultimately, beyond the choice of technique or biomaterial, the most critical factor remains the accuracy of the indication. A detailed radiological assessment using cone-beam computed tomography (CBCT) is essential to evaluate residual bone volume, the integrity of the alveolar walls, and the relationship with adjacent anatomical structures. This analysis must be complemented by an assessment of the periodontal biotype, soft tissue conditions, patient-related factors, and esthetic expectations. Indeed, the therapeutic strategy for a posterior implant site in an elderly patient differs substantially from that required in the anterior maxilla of a young patient with a high smile line and high esthetic demands. In this context, alveolar ridge preservation should be viewed as a valuable therapeutic option when appropriately indicated, integrated within an individualized treatment approach aimed at optimizing biological, functional, and esthetic outcomes in implant rehabilitation [1,4].

Conclusion:

Alveolar ridge preservation represents a clinically relevant approach to limit post-extraction dimensional changes, particularly in sites with high aesthetic or biological risk. Although it does not completely prevent physiological bone remodeling, its effectiveness relies on adherence to fundamental biological principles, including atraumatic extraction, stabilisation of the blood clot, and maintenance of the alveolar socket space. In complex situations involving periapical pathology and buccal cortical plate compromise, the combination of atraumatic extraction, lesion enucleation, and alveolar ridge preservation followed by delayed implant placement allows optimisation of biological and aesthetic conditions, leading to predictable and long-term implant rehabilitation outcomes [1-4].

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