

Preservation of Bone Volume in Implant-Supported Post-Extraction Sockets: Tissue Conditioning during Prosthetic Rehabilitation [†]

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Abstract: Socket preservation is a procedure in oral surgery that is vital to maintain the integrity of the alveolar ridge following tooth extraction, providing a favorable environment for subsequent implant placement. The success of post-extractive implantology relies on osseointegration and the establishment of harmonious soft tissue contours. A supporting literature review was conducted to analyze the socket preservation technique and the role of prosthodontics in facilitating optimal soft tissue healing. Relevant studies and clinical trials published between 2000 and 2023 were included. The search was performed using electronic databases, such as PubMed, Embase, and Scopus, using keywords related to socket preservation, post-extractive implantology, prosthodontics, and soft tissue conditioning. Socket preservation techniques, such as guided bone regeneration and biomaterials, have been proven effective in minimizing bone resorption and preserving the alveolar ridge volume. However, with proper consideration of the prosthetic aspects, these techniques may yield optimal aesthetic outcomes. Prosthodontics plays a crucial role in soft tissue conditioning by providing provisional restorations, functional and esthetic support, and contouring the emergence profile. The socket preservation technique in oral surgery is fundamental for successful post-extractive implantology. However, it is equally important to consider the prosthodontic aspects to ensure adequate soft tissue conditioning. Provisional restorations can help shape the surrounding soft tissues, maintaining a proper emergence profile and enhancing the final aesthetic outcome.

Keywords: socket preservation; oral surgery; post-extractive implantology; prosthodontics; soft tissue conditioning; alveolar ridge; emergence profile; provisional restoration; aesthetic outcome



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1. Introduction

In recent years, implant therapy has undergone significant progress, becoming a more secure, versatile, and reproducible rehabilitation branch. The dentist is now able to satisfy most of the patient's requests, providing optimal solutions for stability and reliability, even in the most extreme situations of severe jaw atrophy or prosthetic complexity [1–3].

The improvement of basic procedures, the broader dissemination of information on oral health, and the advancement of professional hygiene techniques have significantly reduced the number of patients affected by total edentulism, presenting an ever-increasing number of partial or single edentulism cases in daily clinical practice. The indications for replacing a single tooth with an implant are, in particular, advanced periodontal problems, dental traumas, carious processes, and crown or root fractures on already treated

elements [4,5]. Currently, the literature presents conflicting data regarding the healing and treatment of the post-extraction socket, which will be a candidate for the future placement of an osseointegrated implant. The preservation of the residual ridge and its complete volumetric reconstruction through replacement biomaterials and soft tissue management surgical procedures play an essential role in planning adequate implant rehabilitation. The ridge preservation technique involves the treatment of bone deficiency through the use of biomaterial and membranes, exploiting their inductive potential and regenerative capacity to recreate an ideal architecture both from an aesthetic and functional point of view. The resorption of the alveolar ridge following dental extraction is a clinically undesirable phenomenon. There are numerous works in the literature on the healing of the post-extraction socket, the changes caused by bone resorption, and the succession of consequent histological and biological events. Following the avulsion of a dental element, the resorption of the tissue contour occurs after thirty days, with an average of 3–5 mm at six months [6–8]. After a year, some authors report a 50% loss of the width of the alveolar ridge, of which two-thirds of the resorption would occur in the first three months. Therefore, it is essential for implant purposes to preserve the architecture of the post-extraction wound, intending to minimize the bone gap and the deformation of soft tissues over time. The treatment of post-extraction wounds can be classified into three technical formulas:

1. Socket preservation;
2. Ridge preservation;
3. Socket seal.

Socket preservation is a regenerative technique indicated for post-extraction sockets that have maintained their primitive walls intact. Ridge preservation is a specific regenerative technique for post-extraction sockets with bone wall defects. Socket seal refers to the closure and re-composition through suturing of the socket without any interposition of material or graft. The ridge preservation technique is indicated in cases of extractions in high aesthetic value areas, in post-extraction conditions where it is not possible to place an immediate implant due to the loss of bone wall structure, and in maintaining tissue architecture corresponding to edentulous sites to prevent potential invasive interventions in the future [9,10].

The main objectives of ridge preservation are:

- Maintenance and reconstruction of adequate anatomy;
- Bone healing of the socket;
- Maintenance of the site's aesthetics;
- Stabilization and support of soft tissues;
- Facilitation of surgical protocols;
- Facilitation of prosthetic protocols;
- Prevention of connective invasion;
- Maintenance of adequate pre-implant architecture.

Various studies have proposed different bone preservation techniques following extractions, including the insertion of graft material and/or the use of membranes, with success rates of inserted implants comparable to those placed in native bone. Different authors have reported data on the use of biomaterials and/or membranes in post-extraction sites, showing that in the long term, the preservation of the alveolar process is better compared to untreated post-extraction sockets. The histology of such sites showed conflicting results, depending on the biomaterial used, flap closure times, initial defect anatomy, and its vascularization, highlighting the existence of possible interaction of biomaterials with the bone healing process. Studies in humans using demineralized freeze-dried bone allografts, deproteinized bovine bone mineral, or hydroxyapatite have demonstrated the presence of biomaterial in particles surrounded by connective tissue or similar osteoid matrix in post-extraction sites even after 6–9 months. Many authors have instead reported encouraging results, witnessing the histological presence of new mature bone without the presence of osteo-productive material. Other studies conducted on deproteinized bovine

bones in dog mandibles have affirmed the scaffolding function that this material provided for the apposition of new bone. According to Artzi et al., this material provided, at 9 months, excellent aid for the filling of the socket and the preservation of the ridge [11]; other authors, like Becker, have described histologies after 3–7 months with the presence of biomaterial granules [12]. Carmagnola et al. reported that only 40% of the material particle circumference comes into contact with immature bone, and yet, from a clinical point of view, the quantity and quality of grafted sites can allow predictable implant insertion. Many variables, including the type of defect, shape, size, flap, final suture, type of graft, and chosen biomaterial, can make comparisons between studies difficult and provide a reliable and repeatable treatment model [13].

2. Discussion

The avulsion of a dental element invariably results in the loss and upheaval of the anatomy of both hard and soft tissues, thereby altering aesthetics and hampering the harmonization of a future prosthetic rehabilitation. A significant portion of the post-extraction resorption takes place within the first six months (23%) and within the first two years (11%). Clinical results and scientific evidence suggest that the ridge preservation technique is an optimal choice for restoring and maintaining the architecture of the compromised post-extraction socket that is a candidate for future implant therapy [14]. Choosing the right biomaterial is fundamental, as its biological nature, type, formulation, consistency, resorption times, and osteoinductive potential will dictate the choice of surgical technique and the modalities for re-entry. The porcine cortico-medullary bone is a versatile material that is technically easy to use, with high osteoconductive potential, moderate waiting times for re-entry, and good reliability. Using a membrane that serves as a biological barrier, and especially one that maintains a structural schema, stabilizes the clot and facilitates graft stability, thus allowing for the good laying down of the soft tissues and optimal guided healing. Clinical results, also corroborated by evidence in the literature, affirm that treating the post-extraction socket, allowing for the biological timing of osteoformation, while maintaining the anatomy and morphology of the hard and soft tissues in line, enables one to undertake the surgical re-entry and implant placement with the safety and ease of a standard case [15,16].

3. Conclusions

Single-tooth edentulism can find solutions today even in the case of compromised sites and post-extraction sockets with severe deficits of the residual walls. The ridge preservation technique through the grafting of biomaterial and membranes with coronalization of the mucoperiosteal flap can be considered an effective and predictable formula for maintaining and restoring the architecture of the post-extraction wound, a key element of a second linear, simple, and practical implant phase, both from an aesthetic and functional point of view.

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