Polypropylene membrane in post-extraction alveolar repair

With a future perspective on osseointegrated implants

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Introduction

Literature

Despite the technological and scientific advances made in contemporary dentistry, exodontia is still very common in the daily clinical practice. Caries, fractures, periodontal diseases, iatrogenesis, unsuccessful therapies, prosthetic failures, persistent pathologies, malocclusions, automobile and/or sports accidents, neglected oral health and orthodontic indications, among others—all these factors contribute to dental damage.[1] When exodontia is necessary, the repair of the alveolar bone will subsequently begin dynamically. The clot left by the extravasation of blood after the rupture of the vessels present in the periodontal ligament and the neurovascular bundle carries a series of cellular types. These series of cellular types carry proteins responsible for genetic information for bone production. The morphogenetic bone proteins present in the blood platelets initiate extracellular matrix mineralisation in the extraction sites and, thus, the subsequent production of the trabecular framework of bone tissue.[2,3]

Owing to the rapid colonisation of epithelial cells and the expected clot retraction, part of the conical cavity space, which results from the extraction of the dental root, will be occupied by epithelial and connective tissue cells. This connective tissue forms granulation tissue in which there is intense vascular proliferation (angiogenesis), which in turn is necessary for revascularisation and local tissue nutrition. After a few days, the totipotent or pluripotent cells differentiate and the new osteoblasts, as well as the existing ones, secrete a matrix that can mineralise.[4,5] Through a physical barrier, the guided bone regeneration technique aims to contain cell types that are undesirable to the alveolar bone repair, and to favour the immobility of the osteoblasts in the proliferative alveolar site. Being precursors of bone tissue, osteoblasts can emit pseudopodia by initiating the process of secretion of the extracellular matrix that will later mineralise.

The process of development from the osteoid tissue to maturation, within a period of a few months, will have culminated in the formation of concentric lamellae with adequate nutrition, featuring Haversian and Volkmann's canals, which makes the tissue susceptible to the maintenance of the functional activities resulting from masticatory loads, provided that detailed prosthetic restoration has been performed with satisfactory backwards planning.[6] Several materials have been tested as barriers, including castor, polytetrafluoroethylene and even gold screens.[7] However, conflicting results were found and the barriers were not really practical in daily clinical prac-

Fig. 1: Generalised chronic periodontitis was observed during the initial visit. **Fig. 2:** Marked mobility of tooth #13 and a gingival fistula in the area of lost tooth #14.

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tice.[8,9] This article presents a case of the use of a polypropylene membrane post-exodontia with a future perspective on the placement of osseointegrated implants and prosthetic restoration.

Case presentation

A 40-year-old Caucasian female patient attended the private clinic needing periodontal treatment and exodontia. Generalised chronic periodontitis was clinically observed (Fig. 1) with marked mobility of tooth #13 and a gingival fistula in the area of lost tooth #14 (Fig. 2). Radiographs showed dental losses (teeth #2, 14, 17, 18, 30, 31 and 32), generalised horizontal alveolar bone loss, marked vertical bone loss and an angled root of tooth #13 (Figs. 3–5). Subsequently, periodontal treatment was performed and the extraction of tooth #13 was indicated. With the prospect of placing osseointegrated implants and prostheses, the use of regenerative techniques (guided bone regeneration) was suggested. After the patient's consent had been obtained, the use of a polypropylene membrane was discussed.

After the exodontia and the subsequent curettage of the lesions and abundant rinsing with saline solution (Figs. 6 & 7), the polypropylene membrane (Bone Heal, INP) was cut, adapted, inserted and sutured. The membrane was intentionally exposed to the oral environment (Fig. 8). Analgesic, anti-inflammatory and antibiotic drugs were administered right after the surgery. Ten days after the procedure, the remaining sutures and the membrane were removed (Figs. 9 & 10). At that point, no postoperative changes or complications were observed or reported. However, maintenance and immobilisation of the clot were clinically observed, maintaining relative thickness of the alveolar ridge (Fig. 10). After three months, the patient was scheduled for the implant placement procedure and prosthetic restoration, for the purpose of restructuring the remaining ridge.

Discussion

In the period after the exodontia, there is physiological and determinant coagulation retraction originating from the salivary enzymes and the microbiota of the oral cavity itself. Local haemostasis initiates a series of cellular and tissue phenomena common to physiological repair.[10] The fibrin screen interconnects the walls of the alveolus, giving a yellowish and gelatinous appearance to the site. First-line cells of organic or immune defence, like neutrophils, try to prevent the invasion of bacteria from the oral environment. Salivary immunoglobulins and epithelial growth factors also aid in the neutralisation of these invading microorganisms.[2]

Three days after the surgery, the endosteum and the periodontal ligament produce differentiated and undifferenti-

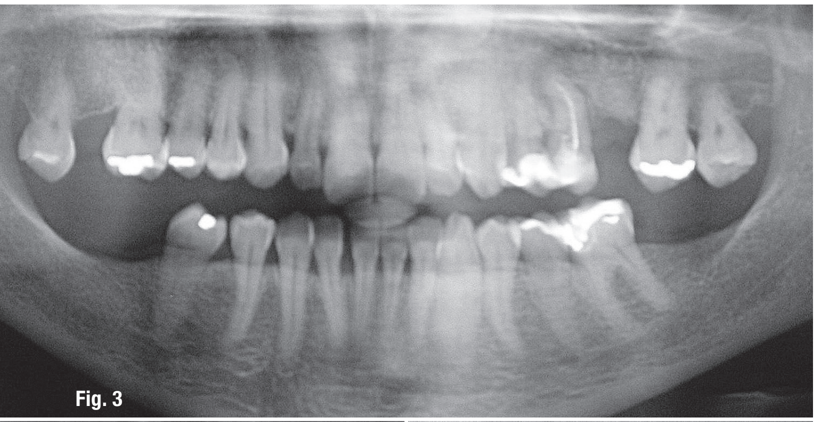
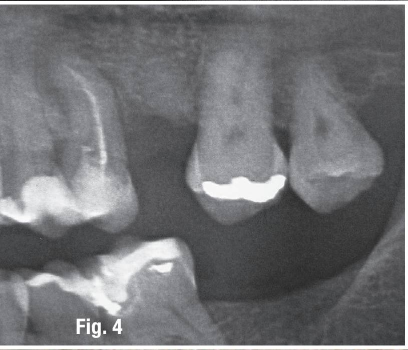


Fig. 3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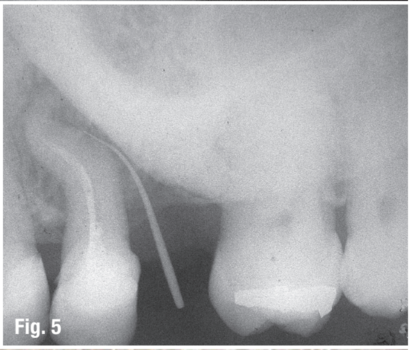
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Fig. 6

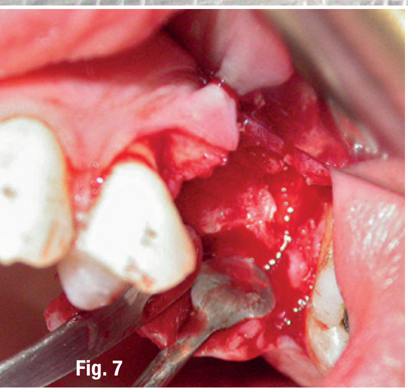
Fig. 7

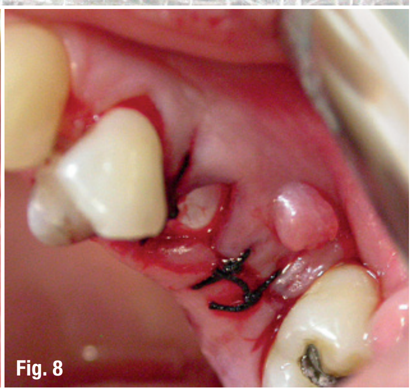
Fig. 8

Fig. 3: Dental losses and generalised alveolar bone loss. **Fig. 4:** Marked vertical bone loss and angled root of tooth #13. **Fig. 5:** Insertion of a gutta-percha cone into the alveolus of tooth #13. **Fig. 6:** Tooth #13 removed, presenting an angled root. **Fig. 7:** Immediate post-exodontic surgical bed. **Fig. 8:** Polypropylene membrane exposed to the oral environment and sutured on the post-op surgical bed (occlusal view).

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Fig. 9: Ten days post-op before removal of the sutures and membrane. **Fig. 10:** Ten days post-op after removal of the sutures and membrane.

ated cells, which contribute significantly to the cellular colonisation of the granulation tissue that forms towards the centre of the alveolus left after the exodontia.[1,3] Four days after the procedure, irregularly formed trabeculae of primitive bone fill the defect. Owing to its restricted function, it only serves as filling and is unable to withstand more intense mechanical forces, such as more vigorous mastication.[11,12] After seven days, angioblastic proliferation occurs in the alveolus centre. Additionally, in the osseous cortical walls, mature or secondary bone tissue interposes the granulation tissue.[2,3] Three weeks after the surgery, there is complete isolation between the postoperative alveolus and the oral cavity. Apicocervically, there is the formation of secondary bone. Up to 35 days after the surgery, new osteoblasts form from osteoprogenitor cells, with osteoid tissue developing. After 45 days, connective tissue is permeated by mature bone tissue with incompletely formed trabeculae. Osteocytes are trapped in the newly formed adult bone tissue.[13] After only four months, the bone tissue is considered morphologically able to withstand more severe mechanical stresses and already reliable regarding upcoming prosthetic restoration.

Prior to implant-supported rehabilitation, a period of four months for the maxilla and six months for the mandible is usually required after the surgery.[14] Even the execution of pre-prosthetic surgeries requires planning based on terminal bone maturation.[15,16] The importance of the immobility of the clot within the context of alveolar bone rehabilitation after the surgical procedure needs to be emphasised. Bone sequestration, restorative material remains, surgical wound infections, abrupt increases in local temperature of higher than 47 °C for a duration of longer than one minute (which causes protein denaturation and minimisation of alkaline phosphatase), untimely movements of the flap or traumatic removal of sutures, among others, hinder alveolar repair.[17]

If replacements and fillings for tooth extraction sites are needed, autogenous bone grafts are considered to be the gold standard. Bone substitutes were developed with the purpose of saving surgical time and making the need for a second surgical stage, with greater morbidity for the patient, redundant.[18–21] Membranes or screens have made it possible for the grafts to remain in position, since the periosteum does not always provide adequate containment owing to extensive bone defects. Surgeries such as maxillary sinus lift, correction of bone defects due to trauma or periodontal problems, augmentation of aesthetic areas after extraction, or periodontal surgeries with connective tissue grafts and apposition of blocks or particles of autogenous bone use membranes or barriers as an aid to bone repair.[22–24]

Membranes made of different materials can be employed for guided bone regeneration. The ideal material should have the following features: it must be able to be cut and shaped; it should be easily adaptable; its mechanical resistance should be compatible with applied loads; it should have great malleability; it should not be expensive; it should not require additional fixation, such as screws or tacks; it should be exposable to the oral environment without promoting infections; it should be applicable without making relaxing incisions; and it should be, if necessary, removable without the use of drills or punch instruments. The polypropylene membrane, as presented in this article, met most of these requirements and fostered osteopromotion.[25]

The polypropylene membrane bears numerous potential advantages. It can be intentionally exposed to the oral environment and the flaps can be kept apart from each other for healing by secondary intention. Moreover, there is no supremacy in the use of granular biomaterials in the alveolus—only the blood clot. In addition, it is not linked to greater financial cost regarding complementary instruments. Furthermore, there is no need for prior hydration. It is dimensionally stable during its retention in the surgical area. It is waterproof and can be removed between seven and 14 days after placement. Moreover, it does not adhere to scar tissue, and the inner surface promotes the adsorption of osteoblasts and precursor cells. It can be used when implants are placed, employing the Schroeder technique with immediate loading, allowing the simultaneous regeneration of bone and grafted gingival tissue and hindering the accumulation of dental biofilm and food debris.[26–30]

In the field of contemporary dentistry, the guided bone regeneration technique with membrane aid is considered an effective alternative for osteopromotion and osteogenesis. In the region of the post-extraction alveolus, the barrier selectivity characteristic protects the clot to facilitate the proliferation of histologically competent cells for the production of bone tissue. In addition, it potentiates the local physiology aiming for a more reliable prosthetic restoration, a better prognosis and longevity.[21,22]

Conclusion

Aid of alveolar bone repair by means of guided bone regeneration is the basis of the osteopromotion phenomenon. Treatment of periodontal defects, alveoli after dental extractions, maxillary sinus lift and alveolar ridge augmentation are common surgical procedures in which guided bone regeneration can be employed. The use of bone substitutes and allogeneic, xenogeneic and alloplastic grafts is considerably more time-consuming and results in greater costs for the patient. The physicochemical characterisation of these bone substitutes provides limitless parameters such as crystallinity, contact surface and compositional constitution. These factors lead to a loss of control regarding bone repair rates and a degradation of biomaterials over time. There is an urgent need for more predictable treatment options that entail both a lower morbidity for the patient and a consequent reduction of costs.

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