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Tooth Extraction Plus Immediate Implant Plus Guided Bone Regeneration with Polypropylene Membrane: A Case Report with 12-years Follow-up

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Abstract

After tooth extraction, some biological tissue repair phenomena occur. Invagination of the gingival epithelial tissue and subsequent resorption of the alveolar bone walls is expected. Clinically, bone resorption can compromise the future installation of osseointegrated implants, hindering the rehabilitation of edentulous areas. Guided Tissue Regeneration and Guided Bone Regeneration techniques can be used to prevent post-tooth extraction bone resorption. These techniques should also be associated with more cautious and preservative extractions to safeguard regenerative results. The polypropylene membrane has been used after tooth extraction with the main aim of maintaining and immobilising the blood clot inside the alveolus and, due to the possibility of exposure to the oral environment, without suffering contamination or adsorption of dental biofilm and subsequent infection. The purpose of this article is to present the case of the use of a polypropylene membrane after the extraction of a molar, in order to preserve and maintain bone tissue for the immediate installation of an osseointegrated implant and the respective implantoprosthetic rehabilitation. The case has been followed up for 12 years.

Keywords: Tissue Regeneration; Bone Regeneration; Oral Surgery; Bioengineering; Implantology

Introduction

After tooth extraction, some biological tissue repair phenomena usually occur. Contact with salivary enzymes and bacterial products from the oral cavity causes the blood clot to shrink. Gradually, tissue repair results in invagination of the gingival epithelial tissue and resorption of the alveolar bone walls. Clinically, bone resorption is observed to be greater in thickness than in height. Considering subsequent dental rehabilitation in edentulous areas, bone thickness becomes an important bone framework for the installation of dental implants [1-15]. In addition, the preservation of peri-implant and mucosal tissues is also necessary, as it is a natural mechanical barrier, especially against the invasion of periodontopathogenic microorganisms [13].

Guided Tissue Regeneration and Guided Bone Regeneration techniques can be used to prevent the bone resorption that is predictable with tooth extraction. When possible, these techniques should be associated with more cautious and preservative tooth extractions to safeguard regenerative results [1-15].

Various types of biomaterials and regenerative techniques can be used to preserve bone after tooth extraction. However, most of these biomaterials must remain submerged and not exposed to the oral cavity, thus avoiding contamination. In order to resolve this clinical situation, the polypropylene membrane was designed to be intentionally exposed to the oral environment and to maintain and immobilise the blood clot after tooth extraction [1-15].

The purpose of this article is to present a case of bone tissue preservation after tooth extraction and prior to the immediate installation of an osseointegrated implant using a polypropylene membrane.

Case Report

A Caucasian male patient, 45-years-old, attended the dental clinic complaining of toothache.

Clinically, the general condition of the oral cavity was satisfactory (Figure 1). However, the lower left third molar was mesialised due to the absence of the lower left second molar. Due to poor dental positioning and oral hygiene difficulties, a caries had developed on its mesial surface, causing painful symptoms (Figure 2).

Figure 1: Initial clinical aspects of the patient showing satisfactory oral condition.

Figure 2: Lower left third molar mesialised and carious, causing painful symptoms.

Virtual planning based on computed tomography images revealed the possibility of installing an immediate implant in the area after tooth extraction (Figure 3). In order to increase and preserve the size of the bone remnant, the use of a polypropylene membrane was suggested.

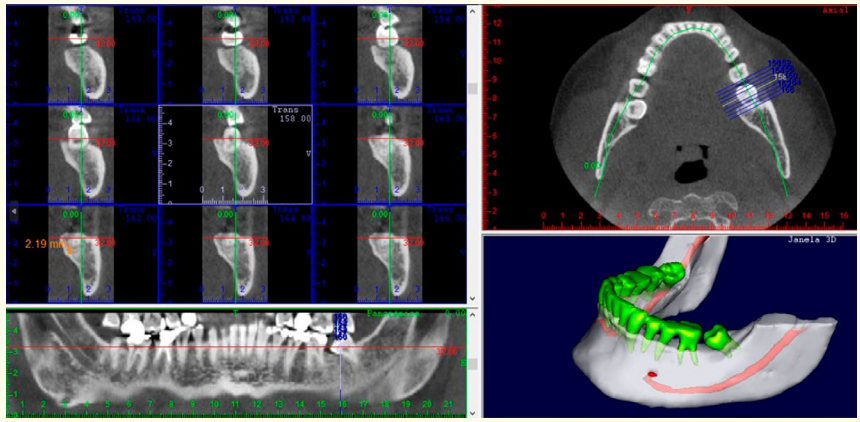

Figure 3: Virtual planning based on computed tomography images for the installation of an osseointegrated implant.

The patient agreed to the procedures and signed a consent form.

Under local anaesthesia, tooth extraction was performed on the lower left third molar (Figure 4), using a delicate technique to avoid bone fracture or loss of the alveolar walls. The socket was curetted and washed, with subsequent bleeding to form a blood clot (Figure 5). The 5.0 X 11mm Internal Hexagon implant was installed (Figure 6). The polypropylene membrane (BoneHeal™, São Paulo, Brazil) was perforated and adapted (Figure 7) to cover the socket and implant (Figure 8). The gingiva was sutured over the membrane, remaining exposed to the oral environment. The patient was prescribed analgesics, anti-inflammatories and antibiotics.

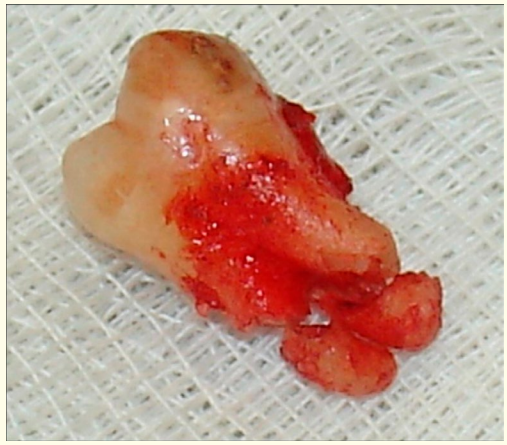

Figure 4: Tooth removed.

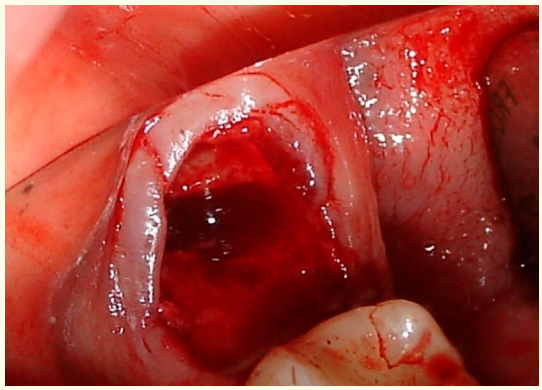

Figure 5: Tooth alveolus with subsequent blood clot formation.

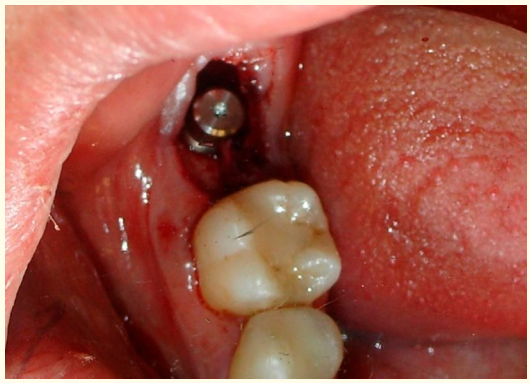

Figure 6: Implant installed.

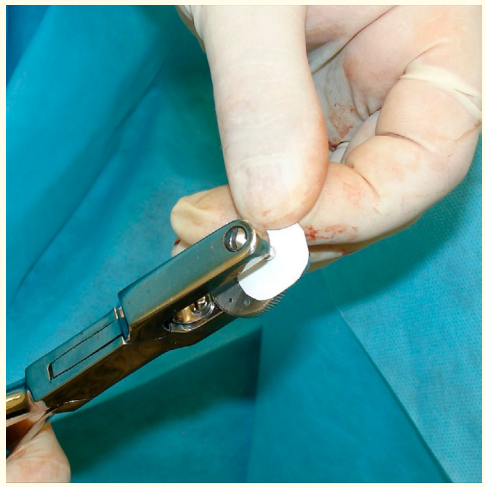

Figure 7: Perforation and adaptation of the polypropylene membrane.

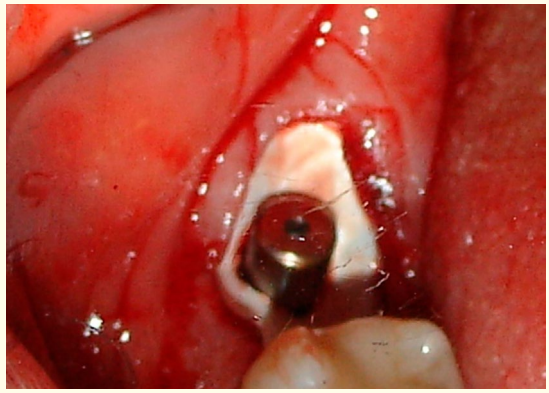

Figure 8: Polypropylene membrane covering the alveolus and implant.

After 7 days, the remaining sutures and the polypropylene membrane were removed (Figure 9). No complaints or complications were reported. After 15 days, the healing abutment was installed (Figure 10). The patient was assessed after 30 days to check for complete healing (Figure 11).

Figure 9: Post-operative evaluation (7 days).

After 3 months, the metal-ceramic crown was made over the installed implant, checked clinically and radiographically (Figures 12 and 13, respectively). The case has been followed up for 12 years.

Figure 10: Healing abutment installation.

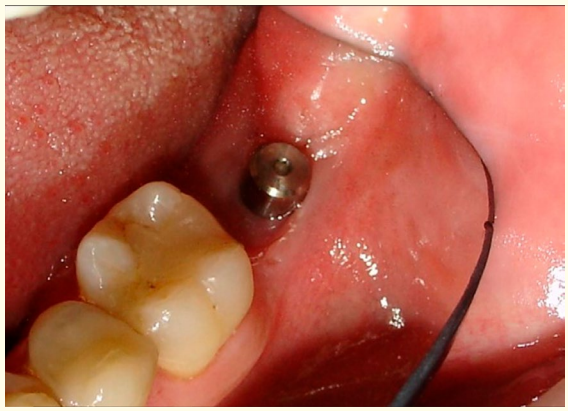

Figure 11: Evaluation after 30 days: complete healing.

Figure 12: Installed metal-ceramic crown.

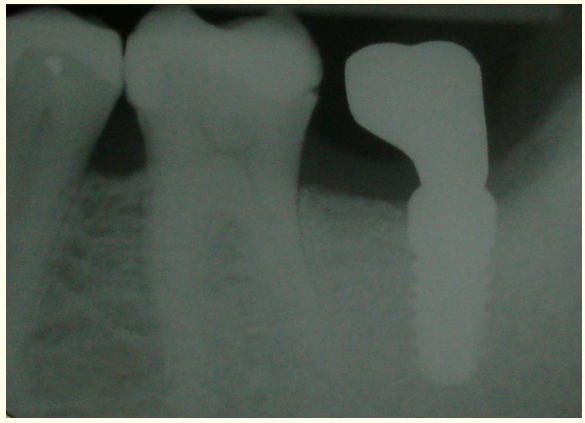

Figure 13: Control periapical radiograph after implant and metal-ceramic crown installation.

Discussion

After tooth extraction as an aggressive and traumatic episode, phenomena such as haemostasis, chemotaxis, angiogenesis, production and maturation of bone tissue are expected, all of which are regulated by the inflammatory process. The genetic information for bone synthesis and maturation involves the biogenesis of bone morphogenetic proteins (BMPs) from platelets, as well as the differentiation of totipotent cells into osteoblasts [16, 17].

After tooth extraction, the blood vessels rupture and a blood clot forms in the alveolus. This is made up of a network of fibrin attached to the alveolar walls. Vascular proliferation is determined by considerable angiogenesis. At this point, physiological retraction of the blood clot occurs, caused by contact with oral microorganisms and salivary enzymes. This is followed by the invasion of epithelial cells. Salivary immunoglobulins and neutrophils prevent the invasion of oral microorganisms, determining the first line of defence of the host [1-15]. Despite all this physiological effort on the part of the organism, resorption of the alveolar bone walls begins at this stage.

Within 3 days, the alveolus is filled with granulation tissue. This is made up of differentiated and undifferentiated cells. The peripheral and central regions of the alveolus are activated by angiogenesis. The blood supply comes from the endosteum and periodontal ligament. Within 4 days, osteoblasts migrate to the region, filling the socket. At 7 days, the process of secretion and deposition of osteoid matrix by osteoblasts begins, with future formation of bone tissue. Bone formation occurs from the periphery to the centre of the socket, interposed with granulation tissue. Within 21 days, the alveolus is covered by epithelial tissue, isolating the surgical site from the oral cavity [18]. Forty five days after the surgical procedure, the bone tissue is matured in the midst of irregular trabeculae. Subsequently, osteoblasts are incorporated and attached to the mature bone tissue, calling themselves osteocytes. Months later, concentric lamellae with Havers and Volkmann canals are formed. The newly formed bone, with adequate nutrition and maturation of the osteoid tissue, becomes viable to receive functional activities resulting from masticatory loads [1-15]. In implantoprosthetic rehabilitation, 4 to 6 months should be waited (mandible and maxilla, respectively) [19].

Based on these physiological phenomena, the dental surgeon should also consider more cautious and preservative tooth extraction in order to maintain the alveolar bone remnant and reduce the expected bone loss. To this end, the maintenance and stabilisation of the blood clot inside the dental alveolus becomes important, as it is a predisposing factor for bone neoformation [1-15, 20].

From this perspective, Guided Tissue Regeneration and Guided Bone Regeneration techniques can be used to prevent the bone resorption that is predictable with tooth extraction [1-15].

Various types of biomaterials and procedures can be used. Autogenous bone grafts are the gold standard, but they must always be submerged and covered by submucosal membranes. Exposure to the oral cavity would cause contamination of these grafts, leading to the loss of the procedure. However, the morbidity caused must be taken into account, as these are two surgical procedures at the same time: preparation of the recipient site and the donor site [1-15, 20-22]. In addition, the autogenous bone tissue must be covered with membranes or barriers, submerged by the total flap to favour healing by first intention [1-11, 13-15].

In view of this clinical need, the polypropylene membrane was designed to maintain and immobilise the blood clot after tooth extraction [1-15], and mainly because of the possibility of exposure to the oral environment [1-11, 13-15, 20-22].

The polypropylene membrane BoneHeal™ (São Paulo, Brazil) has a smooth outer surface, which makes it difficult for bacterial plaque to accumulate in contact with the oral cavity. On the other hand, its inner surface is discreetly textured, which favours the adsorption, immobilisation and retention of the blood clot inside the dental alveolus. The membrane does not undergo hydration, soaking or dimensional changes, making it stable and impermeable. The polypropylene membrane is malleable and therefore easily adapted and installed, as can be seen in Figures 7 and 8. It does not require relaxing incisions or fixing screws for installation. Its low cost makes it accessible and favours its use. The polypropylene membrane can be removed in 7 to 14 days [1-15, 17, 19].

There is no need for additional biomaterials to fill the alveolus or bone defect. The own local physiology of the patient is enhanced - thanks to chemotaxis and angiogenesis - by the use of the polypropylene membrane to maintain the blood clot inside the dental alveolus. The clot is supplied with platelets and growth factors involved in bone healing and neoformation [20, 21].

The polypropylene membrane was specially developed for use after tooth extraction with a view to the future installation of osseointegrated implants [1-7, 11, 13, 15]. However, due to its similar characteristics to the dental alveolus, it can be used in bone cavities in general for the purpose of bone regeneration. The use of polypropylene membranes after surgical removal of cystic lesions has been reported [8, 9]. Bone regeneration after severe bone loss in implants affected by peri-implantitis also showed satisfactory results [10]. The polypropylene membrane used in the simultaneous elevation of the maxillary sinus membrane followed by the installation of dental implants without bone grafting also showed satisfactory results [12]. Recently, aesthetic and functional benefits have been presented by preserving the peri-implant mucosa, protecting the installed implant [13]. After the explantation of a fractured implant, guided bone regeneration was achieved with a polypropylene membrane for the subsequent reinstallation of another implant [14].

Conclusion

Bone resorption of the walls of the dental alveolus is to be expected after tooth extraction. It usually occurs more in thickness than in height. In order to preserve and reduce bone resorption of the walls of the dental alveolus, it is essential to maintain the blood clot inside it after tooth extraction. The use of a polypropylene membrane is effective in maintaining the clot, favouring bone regeneration and the future installation of an osseointegrated implant and implantoprosthetic rehabilitation.

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