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CASE REPORT: PRESERVATION OF THE ALVEOLAR RIDGE FOR SUCCESSFUL FIXED ZIRCONIA DENTAL RESTORATION

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Abstract

Introduction: Alveolar ridge preservation is a common dental procedure designed to preserve the space left after tooth extraction. It involves the use of a natural collagen membrane derived from the porcine pericardium, used alone, or in combination with a bone graft to replace missing bone before implant placement and prosthodontic reconstruction. This case report aims to demonstrate the importance of alveolar ridge preservation after tooth extraction, the method, and its outcome for successfully placing a fixed prosthetic construction.

Case report: The technique uses a natural collagen membrane (Jason membrane) derived from porcine pericardium that can be resorbed, in combination with the xenogeneic bone graft (Carebone, Botiss) and subsequent zirconium dioxide fabrication after 6 months in a 45-year-old female patient.

Conclusion: Regeneration of the alveolus with Jason membrane and artificial bone Carebone, can minimize further bone resorption and allow for successful placement of prosthetic solution.

Keywords: extraction, alveolus, alveolar ridge, PMMA, zirconium crowns

Introduction

The most common indications for tooth extraction are untreated caries, root fractures, advanced periodontal disease as part of orthodontic treatment, trauma, and injury [1]. After the extraction, the alveolar ridge undergoes a remodeling process that influences the rehabilitation treatment in edentulous areas. The alveolus walls undergo significant three-dimensional resorption, resulting in morphological and topographical changes in the surrounding hard and soft tissues. The soft tissue contours depend on the underlying bone and ridge anatomy and since a series of biological processes occur, they initiate significant local anatomical changes.

Most studies show that alveolar ridge resorption after extraction is an irreversible cumulative process, and results in the loss of the vertical and horizontal dimensions of the alveolus [2]. Alveolar ridge preservation (ARP) measures include the use of a wide range of bone substitutes, barrier membranes, biologically active materials, and various surgical techniques and protocols [3].

The preservation of the alveolar ridge is important for the further treatment of the edentulous space. Dental implants are very often the first choice. However, their use in the treatment is not always feasible due to the patient's age, inadequate bone volume, or the high cost of implant therapy. Therefore, other alternative solutions are also functional, with good aesthetics, and an excellent replacement for lost teeth, as a definitive long-term solution [4].

Modern dental materials such as metal-free ceramics and zirconium dioxide produce highly aesthetic restorations, without additional oral surgical interventions. Fixed prosthetic reconstruction connects the supporting teeth and replaces the missing teeth. The purpose of dental bridge fabrication is to restore the aesthetics and function of lost teeth and to improve the health of the stomatognathic system [5].

This case report aims to demonstrate the importance of alveolar ridge preservation after tooth extraction, the method, and its outcome for successfully placing a fixed prosthetic construction.

Case report

A 45-year-old female patient with no prior medical history presented to the dental office with pain and dislocation of the maxillary left lateral incisor, which was the result of a traumatic injury. The patient underwent detailed clinical and radiographic examinations, which revealed that the trauma had resulted in

a complete fracture of the left upper lateral incisor in the apical third of the root, with a slight dislocation of the coronal portion of the tooth (Figure 1).

Figure 1. Orthopantomogram status showing trauma fracture of the upper left lateral incisor

An intraoral examination revealed the tooth with dislocation of the coronal part and severe luxation (Figure 2). The patient was presented with several treatment options, which included surgical extraction of the fractured upper left lateral incisor, followed by ARP (alveolar ridge preservation) and replacement of the lost tooth with a dental implant or porcelain crowns. After a detailed examination and analysis of the teeth' occlusion, it was decided to extract the fractured tooth and manufacture the fixed full ceramic zirconium crown reconstruction to recover the lost function and esthetic.

Figure 2. Initial state – intraoral view

The fractured tooth was extracted under local anesthesia (Scadonest 2%), and intraoperatively, a fracture was found on the root below the level of the tooth crest. The crown was extracted separately, and then the fractured root was extracted with minimal surgical trauma, after which curettage of the alveolus and irrigation with sterile saline was performed.

Jason® membrane 15x20mm a natural collagen membrane obtained from the porcine pericardium, was placed in the alveolus, for dental regeneration of the bone and surrounding tissue. We chose this mesh because of its small thickness, and the specific composition and structure of the pericardial collagen fibers which provide a natural and long-lasting barrier function.

After adjusting the membrane in the area of the defect (alveolus), an artificial bone Carebone (Botiss) consists of 100% pure bone minerals of bovine origin was placed. Next, the alveolus was sutured with Monamid 5/0 (Surgical, polyamide6-6.6 Suture Nonabsorbable, Uncoated Synthetic, Monofilament, Blue) (Figure 3).

Figure 3. Alveolar ridge preservation after tooth extraction

Postoperatively, the patient was prescribed antibiotic therapy Tabl. Pancef á 400mg for 5 days and analgesic therapy Tabl. Ibuprofen forte á 400 mg for 3 days. The surgical suture was removed 10 days after the surgery, and the healing showed well-preserved soft tissues with keratinized epithelium.

The next step was the preparation of the teeth for prosthodontic restoration, which involves removing a significant portion of the tooth structure to create space for the future crown. An assessment was made of the amount of tooth substance reduction required, the condition of the existing tooth structure, and any potential complications that may arise during the preparation. The patient decided that she needed the complete aesthetic recovery of her upper jaw so ten upper frontal teeth (11, 12, 13, 14, 15, 21, 23, 24, 25, 26) were prepared, with great attention to maintaining the natural contours of the teeth and the occlusal surface. (Figures 4, 5).

Figure 4. Preparation of the upper frontal teeth (11, 21, 23)

Since zirconia crowns are not thick and do not have a metal base, these crowns require minimal or less tooth preparation. After the teeth were prepared, a digital impression was taken with an intraoral scanner, and the STL file was sent to a dental laboratory, where the future appearance of the teeth was designed using digital technology.

Next, a temporary bridge was milled of polymethyl methacrylate (PMMA) material, in order to provide protection, mechanical resistance, and durability over a longer post-extraction healing period (Figure 6).

Figure 5. Preservation of the alveolus after suture removal

Figure 6. Temporary bridge from PMMA, frontal view

The temporary PMMA crowns that were placed on the patient's prepared teeth were used for long-term therapy in prosthetic rehabilitation. They provided high aesthetics for the patient, protection of the prepared teeth from pain, and mechanical and chemical damage. The patient wore the temporary PMMA crowns for 6 months. After 6 months, a CBCT (Cone-beam computed tomography systems) was performed to check the bone regeneration.

The CBCT evaluation showed bone regeneration in the alveolus area, good preservation of the gingival contour, and fully preserved tips of the interdental papillae, which is also very important when placing the definitive fixed construction in the frontal area. The preparation process for zirconia crowns is also crucial for the success of the restoration. Achieving perfect fit and long-lasting results requires precision at every stage, from the initial tooth preparation to the final refinement of the margins.

The permanent reconstruction was made of zirconium dioxide crowns, which were placed on the prepared teeth in the upper jaw. The zirconium crowns were made of zirconium dioxide, which is a highly biocompatible material that does not cause allergies and is characterized by durability and high strength. Since the material has high transparency and good optical properties, the crowns have excellent aesthetics and an identical appearance to natural teeth (Figure 7).

Figure 7. Definitive fixed construction frontal view of zirconium crowns

Discussion

Alveolar ridge resorption following a tooth extraction is an irreversible process primarily resulting from a local inflammatory response that leads to a transient dysregulation of osteoclastic genesis, usually initiated immediately after extraction [6]. However, each individual differs in terms of the degree of bone resorption, which depends on various systemic and local factors that, after tooth extraction, lead to significant changes in the hard and soft tissues of the alveolar ridge in the maxilla [7]. Preventing alveolar bone resorption is crucial to reduce the amount of bone accumulation that may be required in future fixed prosthetic therapy. Preservation of the alveolus ensures an aesthetic outcome by maintaining the dimensions of the ridge, and hence the natural profile of the gingiva [8].

Techniques for preserving and maintaining the horizontal and vertical shape of the alveolar ridge after tooth extraction include: the use of bone grafts (autografts, allografts, xenografts, or alloplastic materials); soft tissue grafts; guided bone regeneration (with resorptive or non-resorptive barriers), biologically active materials (growth factors), or combinations [9].

There are a variety of treatment options for the replacement of missing teeth including removable partial dentures (RPD), conventional fixed dental prostheses (FDP), or implant-retained prostheses. Implants are often the treatment of choice. However, they are not always a feasible solution due to patient age, inadequate bone volume, frequent office visits, and high cost [10].

In agreement with the patient, a decision was made to fabricate a fixed prosthetic solution with a zirconium bridge after tooth extraction and preservation of the alveolar ridge. This treatment method is minimally invasive with very little or no loss of dental hard tissue leaving the possibility for further treatments.

The granulation tissue in the alveolus left after the extraction should be physically removed by debridement with a surgical instrument. Some operators prefer to irrigate the alveolus with saline. However, the study by Tolstunov et al. showed an increased incidence of alveolar osteitis after irrigation, which may be associated with blood clotting disorder [11]. In our case, we did not irrigate the alveolus with saline for this very reason. We suggest that the grafting material used to fill the alveolus should be placed gently, using an aseptic technique, and the alveolus should not be overfilled.

Some surgeons prefer to moisten the graft material with saline or blood before use to improve placement in the alveolus, but others feel that moistening the graft will reduce the capillary action of blood absorption on the graft [12]. In our study, following the recommendations of some authors, we left the graft material dry or moistened it with autologous blood. In the past decade, the use of various materials and techniques for preserving the alveolar ridge after tooth extraction has received considerable attention.

However, the question of whether the use of grafts and membranes is necessary to preserve the alveolar ridge continues to intrigue. Several meta-analyses have been published addressing this issue. In

2011, Ten Heggeler et al. conducted a systematic review of the effect of alveolar ridge preservation therapies after tooth extraction in the frontal region [13]. The findings of this study showed that with natural healing after tooth extraction, the reduction of the alveolus in width ranges between 2.6 and 4.6 mm, and in height between 0.4 and 3.9 mm. In a meta-analysis by Hammerle et al. presented at the Sixth Expert Meeting: Evidence-Based Knowledge on Biology and Treatment of Extraction Sockets Including the Placement of Dental Implants, it was shown that the mean horizontal reduction of the alveolar ridge was 3.80 mm, while the mean vertical reduction was 1.24 mm within 6 months after tooth extraction without ridge preservation therapies [14]. The scientific evidence from all these systematic reviews suggests that alveolar ridge preservation techniques have significant benefits for subsequent treatment because they result in significantly less vertical and horizontal resorption of the alveolar ridge. ARP with xenograft or allograft has shown approximately 2 mm less reduction in alveolar ridge height and width compared to no grafts after extraction [15]. Although ARP is effective, some authors argue that it interferes with normal healing of the alveolus and is of no benefit [16].

Barrier membranes are often used to maintain bone growth space. These can be either resorbable or non-resorbable. Non-resorbable membranes show greater bone filling and favorable marginal tissue response. Resorbable membranes do not require a second operation for removal and show good soft tissue healing. The principle lies in preventing gingival epithelial and connective tissue from penetrating the defect through cellular occlusive membranes to allow certain cells to regenerate the lost tissue in the defect [17].

Today, there is a wide range of bone graft materials that are placed in the alveolus after tooth extraction. To preserve the alveolar ridge in our patient following the conclusions of most studies, we used a xenograft – Carebone, which was sterilely and traumatically placed in the alveolus in a surgically appropriate manner in combination with a resorbable collagen membrane (Jason membrane). According to the above-mentioned meta-analysis, the use of xenogeneic or allogeneic graft materials in combination with resorbable collagen membranes has the best outcome compared to other grafting materials in terms of preserving the horizontal ridge. This paper considers that the rationality of this combined treatment is that the membrane acts as a barrier that prevents epithelial growth in the alveolus, while the bone graft serves to prevent the possible collapse of the membrane and to improve bone regeneration through the processes of osteoinduction and osteoconduction.

Some authors do not advocate routine antibiotic therapy for ARP, given the risk of antibacterial resistance and side effects of the drug. They recommend removing the sutures as soon as the wound is sufficiently stable to reduce the penetration of bacteria and the risk of wound infection [18]. However, according to other authors, the use of antibiotic therapy is mandatory in order to prevent postoperative infection of the alveolus and wound [19]. In our case, in order to prevent postoperative infectious complications, we used dual antibiotic therapy with cephalosporin and metronidazole for gram-positive and gram-negative bacterial flora.

The most commonly used materials for fixed temporary crowns include polymethyl methacrylate (PMMA) resin, polyethyl methacrylate (PEMA) resin, polyvinyl methacrylate resin, bis-acrylic composite resin, and visible light urethane dimethacrylates. The choice of material for the fabrication of temporary crowns depends on the mechanical, and physical properties, ease of use, and intraoral biocompatibility of the material [20].

Although PMMA has weaknesses such as poor color stability, high shrinkage during polymerization, marginal mismatch, easy absorption of liquids, and unpleasant odor, it was the material of choice in our case. In our opinion, PMMA is more economical, has high resistance to breakage, and can be used for a longer period. The marginal fit of the temporary crown with PMMA is as precise as the final crown, which prevents gingival irritation, and inflammation of periodontal tissues, and also provides an aesthetic result. By making appropriately made temporary crowns with a convex surface towards the alveolus of the extracted tooth, a concave ridge bearing is formed with preserved papillae in the space towards the neighboring teeth. CAD/CAM temporary crowns made of PMMA is a new concept in dentistry, which still needs to be explored concerning the marginal gap, thus replacing the use of conventional temporary crowns made of PMMA.

The design of the final restoration must follow the basic requirements for restoration such as function, phonetics, and aesthetics, as well as the use of appropriate materials. Zirconia ceramic materials possess excellent hardness and chemical stability, they come in a variety of dentin shades to achieve natural aesthetics. Stabilized zirconia, a material with incredible mechanical properties and strength, is used for the production of dental bridges, as a substitute for metal abutments [21]. In a meta-analysis by Alzanbaqi et al. the superiority of zirconia crowns over metal-ceramic crowns is emphasized in all clinical aspects including gingival and periodontal health, color stability, fracture resistance, marginal integrity, surface roughness, recurrent caries, and crown contour [22]. Although some studies have shown that metal-ceramic crowns have a higher retention rate than zirconia crowns, most authors suggest that the retention and fixation of zirconia crowns with an adhesive bonding technique is quite acceptable [23].

Conclusion

Pre-prosthetic surgery is the preparation of the soft and hard tissues of the oral cavity to enable functional and aesthetically better prosthetic rehabilitation. ARP is a clinically proven and safe approach to preserve the alveolar ridge and soft tissues after tooth extraction. Preservation of the alveolus and its healing in the post-extraction period allows for a longer period of time until the fabrication of the definitive fixed prosthetic solution. This advantage allows for the replacement of lost teeth, preservation of the gingival contour as well as excellent functionality and aesthetics for the rehabilitation of the patient's stomatognathic system. Zirconium crowns offer an excellent alternative for replacing extracted teeth, due to their exceptional hardness, resistance to abrasion and breakage, complete indifference to living tissues and biocompatibility, as well as exceptional aesthetics. Therefore, they are preferred as the material of choice for adequate preservation of the alveolar ridge after tooth extraction.

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