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Research Article

Comparative Study of Extraction Socket Preservation Using Autogenous PRF and TCP

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Abstract

Guided tissue regeneration is one of the clinical techniques used in contemporary dentistry in the management of bone loss. The current study compares the healing pattern of platelets rich fibrin (PRF) and TCP (tricalcium phosphate) in the management of extraction sites after atraumatic tooth extractions.

Method: Atraumatic extractions were carried out on 2 teeth to preserve the morphology or socket size. Thirty percent HA (Hydroxylapatite) and 70% Tri calcium phosphate were mixed with the patient's blood and inserted into the extraction socket of the first upper premolar without condensation, while PRF was inserted into the canine socket. Both sites were sutured and patient was followed up for 4 weeks. After 4 weeks a bone density measurement was done by CBCT and bone was harvested by a 3.2 trephine drill and 2 implants neobiotech IS2 3.5 X 13 mm were placed.

Results: CBCT (Cone beam computer tomogram) showed nearly equal bone density in both sockets. Examination after 4 weeks showed equal results in both sockets. PRF socket has the advantage of having well organized woven bone trabeculae and lined with osteoblast cells while in the TCP sample there was irregular woven bone trabeculae with various sizes and the absence of osteoblast cells.

Conclusion: Though PRF and TCP generated bone of the same density, their mechanisms of bone formation was different. The PRF socket had the advantage of having well organized woven bone trabeculae and lined with osteoblast cells while in the TCP sample there was irregular woven bone trabeculae with various sizes and the absence of osteoblast cells. Demonstrating the osteogenic potentials of PRF due to its growth factors contents as compared to TCP that acts as a scaffold. Both of the materials are useful for socket preservation.

Keywords: *PRF; TCP; Extraction Socket; Bone Density; Osteoblasts; Socket Preservation*

Abbreviations

PRF: Platelets Rich Fibrin; HA: Hydroxylapaptite; TCP: Tricalcium Phosphate; CBCT: Cone Beam Computer Tomogram

Background

Implant dentistry has advanced in recent years but one of its major challenges is the placing of an implant is bone loss. The answer to these losses in contemporary dentistry is guided tissue regeneration. Because of this, the guided tissue regeneration (GTR) technique is currently used in dentistry for periodontal surgery, oral surgery, implant dentistry and reconstruction of maxillomandibular defects.

The basic premise for this technique is to allow for osseous regeneration prior to soft tissue migration into the area of interest. This is accomplished with the use of membranes that prevent the migration of the soft tissue element into the bony defect [1]. Successfully osteo-integrated implants essentially require adequate quality and quantity of bone at the implant site.

Insufficient quantity of bone due to tooth loss may result in rapid resorption of alveolar bone due to lack of intra-osseous stimulation by periodontal ligament (PDL) fibers, for example, pneumatization of maxillary sinus following tooth loss [2]. Apart from tooth extractions, ridge defects may develop as a result of surgery, trauma, infection, or congenital malformations. Therefore the goals of osseous replacements are maintenance of contour, elimination of dead space, and reduction of postoperative infections thus enhancing bony and soft tissue healing. The use of bone grafts or bioactive materials for the replacement grafts for the replacements of hard bone tissues are now widely used in contemporary dentistry to promote bone formation and periodontal tissues regeneration.

Once a tooth is extracted, the alveolar ridge inevitably undergoes remodeling with associated resorption which diminishes the size of the ridge. It leads to compromises in the functional and aesthetic outcomes of implant and thus hard and soft tissue augmentations are needed [3,4].

Loss of alveolar bone may be attributed to factors such as endodontic pathology, periodontitis, facial trauma and aggressive maneuvers during extractions e.t.c. Millions of teeth are still extracted annually which eventually end up in dental implant or prostheses replacements [5].

Bone grafting is a surgical procedure that replaces missing bone with a regenerative material that can originate from patient's own body, of synthetic or natural substitute. Bone grafting is possible because bone tissue has the ability to regenerate completely if provided the space into which it has to grow. As natural bone grows, it generally replaces the graft material completely resulting in a fully integrated region of new bone [2].

Most extractions are done with no regard for maintaining the alveolar ridge [6,7]. Whether due to caries, trauma or advanced periodontal disease, tooth extraction and subsequent healing of the socket commonly results in osseous deformities of the alveolar ridge, including reduced height and reduced width of the residual ridge [7]. This is because after extraction, alveolar socket undergoes subsequent remodeling process which is a means of natural additional atrophy. It begins as soon as the tooth is extracted and within a period of 3 months almost 50% alveolar ridge gets resorbed [8]. Additional loss of bone occurs when the extraction is not performed atraumatically or when the buccal plate of the alveolar bone is compressed after a tooth extraction.

The severity of the healing pattern may pose a problem for the clinician in 2 ways: it creates an esthetic problem in the fabrication of an implant-supported restoration or a conventional prosthesis and it may make the placement of an implant very challenging [9]. However, it is possible to minimize such problems by simply carrying out ridge preservation procedures in extraction sockets using grafting materials with or without barrier membranes [10]. The various regenerative biomaterials used for socket augmentation are grafts, membranes, biologic modifiers, and platelet concentrates [5].

Autographs form the gold standard for bone graft materials but other synthetic materials can be used when they are bioactive. Bioactive materials are materials that can cause a positive reaction after implantation in terms of bony tissue formation, strengthening or interlocking, which in turn promotes regeneration of the bone and its functions. Bonding osteogenesis occurs as a result.

Platelet-rich fibrin (PRF) and the mineralized plasmatic matrix (MPM) are examples of platelet concentrates used for tissue regeneration in dentistry.

Various platelet-derived products or platelet concentrates have been introduced that act as biological mediators aiding the healing response. Platelet-rich fibrin (PRF) is one such product that has proved its worth and has edged past the others. The Choukroun's platelet

rich fibrin has opened the flood-gates in the field of dentistry, majorly focusing on the improved healing and regeneration [11]. Thus PRF has also been tagged as a healing biomaterial [11].

Platelet-rich fibrin (PRF) belongs to a new generation of platelet concentrates with simplified processing without biochemical blood handling. It is a strictly autologous fibrin matrix containing a large quantity of platelet and leukocyte cytokines [12]. The use of platelet gel to improve soft and hard tissue regeneration is still a recent technique in dental implantology and periodontology [13,14].

Examples of bioactive materials include synthetic calcium phosphates (tricalcium phosphate (TCP), some formulations of calcium sulfate (CS) and hydroxylapatite (HA). Materials like TCP are osteoconductive because osteoblasts adhere to them and deposit bony tissue on their surface. The biomaterial forms a scaffold for closing the bony defect [15].

Calcium phosphates belong to the group of bioactive synthetic materials and its most frequently used are the hydroxyapatite and the tricalcium phosphate. These types are commonly used due to their osteoconductivity, crystallographic structures, and chemical composition similar to the skeletal tissue. They are classified according to their "resorbability," that is extent of degradation *in vivo*. Hydroxyapatite has been described as "nonresorbable" and tricalcium phosphate has been described as "resorbable" [16,17].

Calcium phosphate materials show a positive interaction with living tissues that also include differentiation of immature cells towards bone cells [16,17]. These materials also have chemical bonding to the bone along the interface, thought to be triggered by the adsorption of bone growth-mediating proteins at the biomaterials surface [16,18]. Hence, there will be a biochemically mediated strong bonding osteogenesis [19,20]. In addition to compressive forces, to some degree tensile and shear forces can also be transmitted through the interface ("bony in-growth").

Calcium phosphate materials are similar to bone in composition and in having bioactive and osteoconductive properties. It presents in different forms such as cements, composites, and coatings when used in many medical and dental applications [21].

Extraction socket grafting with the pure-phase beta-TCP covered with either a resorbable collagen or dense polytetrafluoroethylene barrier is a predictable method for preserving alveolar dimensions. These graft material has been shown clinically to resorbs radiographically, and histological to a high percentage in the timeframe desired between extraction and dental implant placement. In addition, regenerated material in the socket using TCP has been shown to have enough density to support implant placement with subsequent loading in the 4- to 6-month period [22].

The current study compares the healing patterns of 2 extractions sockets after placements of 2 different regenerative materials using histologic and radiographic evidences.

Material and Method

A healthy 42 years women presented to the Dental Smile Center, Alexandra (Egypt) with a 3 years post and core treatment. Her chief complaint was loss of retention of fixed restoration over posts in upper right canines and upper right 1st premolar (Figure 1, 2).

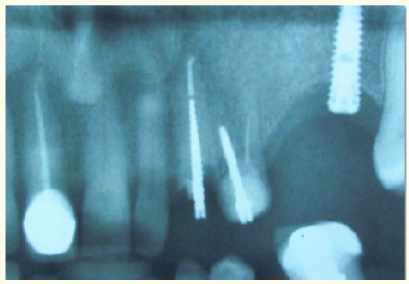

Figure 1: *Periapical x-ray of tooth.*

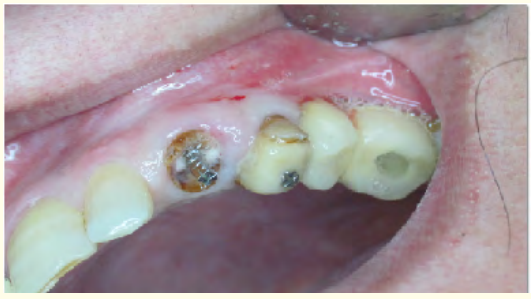

Figure 2: *Fractured crown with dental post.*

The patient was a nonsmoker with no history of any periodontal or debilitating disease. Intra-oral clinical examinations revealed moderate oral hygiene. The periapical radiograph of the site revealed a normal bone morphology. There was also a significant amount of buccal bone and a thin gingival biotype around the teeth. Her recent dental history included placement of several implants with some degree of bone loss around the neck of the implant. Her previous dental treatments were rendered by different surgeons.

Clinical Procedures

Atraumatic extractions were carried out on the 2 teeth using the periotome to preserve the morphology or size socket.

Thirty percent HA and 70% Tri calcium phosphate were mixed with the patient's blood and inserted into the extraction sucket of the first upper primolar without condensation (Figure 3).

Blood samples were taken from the patient's forearm without anticoagulant in 10-ml tube and immediately centrifuged at 3000 rpm (approximately 400g according to Chokroun's calculations) for 10 minutes [23]. Within a few minutes, the absence of anticoagulant allows activation of the majority of platelets contained in the sample to trigger a coagulation cascade. Fibrinogen is at first concentrated in the upper part of the tube, until the effect of the circulating thrombin transforms it into a fibrin network [24].

A fibrin clot is then obtained in the middle of the tube, just between the red corpuscles at the bottom and acellular plasma at the top (Figure 3 and 4). Platelets are theoretically trapped massively in the fibrin meshes [24].

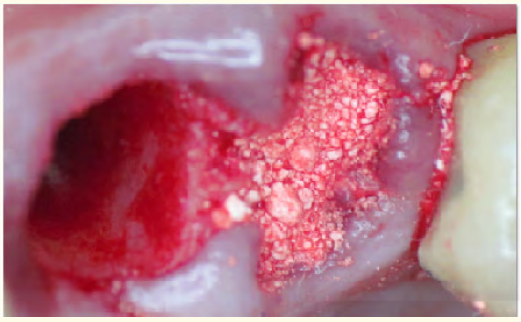

Figure 3: Mixed TCP with blood.

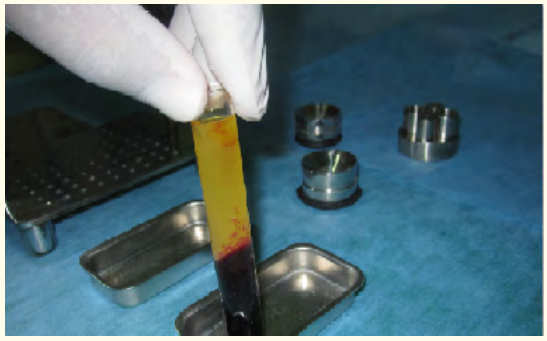

Figure 4: *Centrifuged blood.*

The clot is removed from the tube and the attached red blood cells scraped off and discarded (Figures 5, 6). The PRF clot (Figure 7) is then placed on the grid in the PRF box (Figure 8) and covered with the compressor and lid. This produces an inexpensive autologous fibrin membrane in approximately one minute.

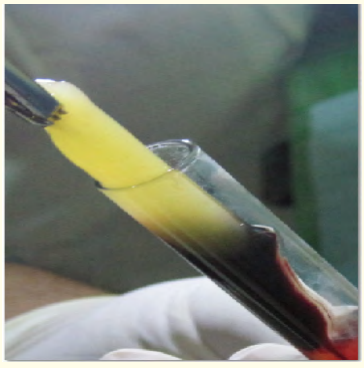

Figure 5: *Separation of PRF from blood.*

Figure 6: *PRF.*

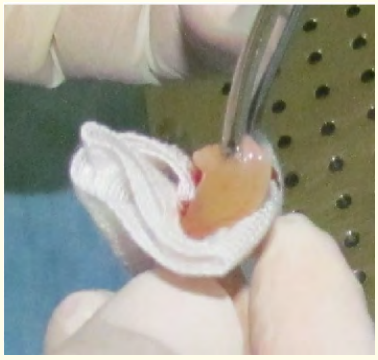

Figure 7: *Compression of PRF with guaze.*

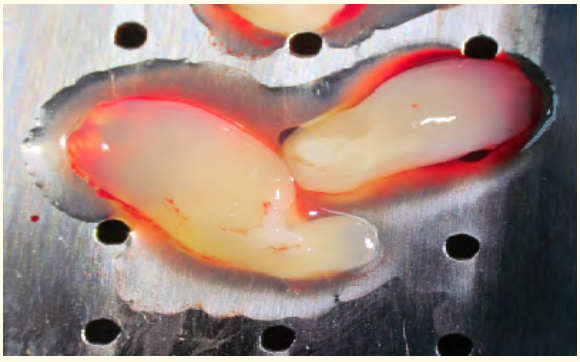

Figure 8: *Separation into a thin layer.*

The PRF box was devised to produce membranes of constant thickness that remain hydrated for several hours and to recover the serum exudate expressed from the fibrin clots which is rich in the proteins vitronectin and fibronectin. The exudate collected at the bottom of the box may be used to hydrate graft materials, rinse the surgical site (Figure 9,10) and stored as autologous grafts [23]. After removing the cover of PRF membranes were obtained from the PRF clots. With a specific tweezer the membranes was inserted in the canine socket (Figure 11).

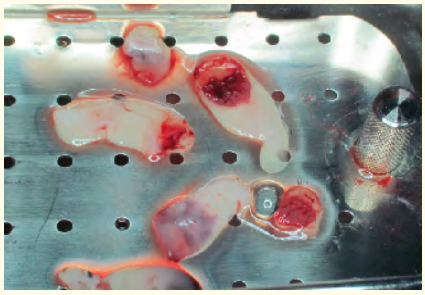

Figure 9: *Aggregates of PRF.*

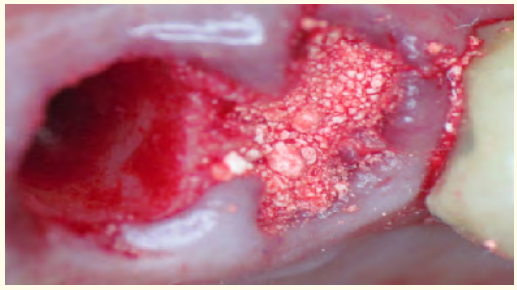

Figure 10: *TCP in extraction socket.*

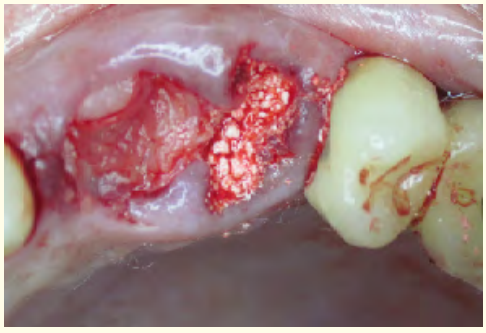

Figure 11: *PRF and TCP in sockets.*

The edges of the mucosa was approximated to each other and sutured using 3 – 0 Monocryl sutures (Figure 12).

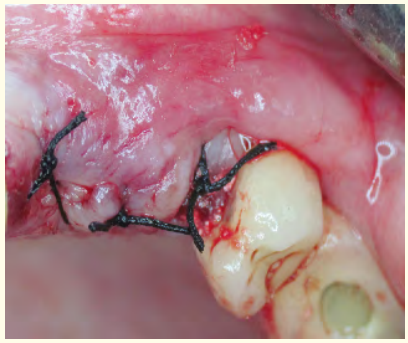

Figure 12: *Sutured extraction sites.*

Healing was uneventful, and the patient was followed up for 1 month postoperatively with oral hygiene instructions strictly reinforced by rinsing with 0.12% chlorhexidine mouthwash.

After 4 weeks a bone density measurement was done by CBCT and bone was harvested by a 3.2 trephine drill and 2 implants neobiotech IS2 3.5 X 13 mm were placed.

Consent was taken from the patient and privacy maintained.

Results

Histological evaluation of decalcified section of PRF (Figure 13) showed connective tissue mass that is consisting of well-organized woven bony trabeculae and lined with osteoblast cells. The surrounding stroma shows fibrous tissue bundle with some hemorrhagic area. While the TCP decalcified sample (Figure 14) showed a connective tissue mass consisting of irregular woven bony trabeculae with varying sizes and the surrounding stroma with some hemorrhagic areas.

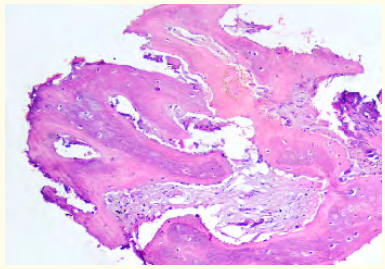

Figure 13: *Histology of PRF.*

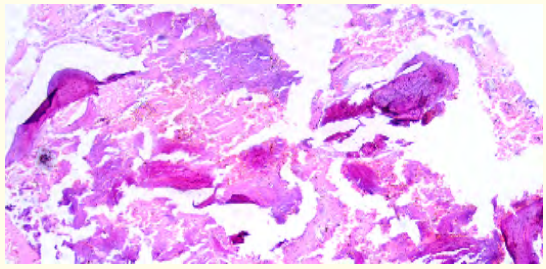

Figure 14: *Histology of TCP.*

CBCT showed nearly equal bone density in both sockets.

Clinical examinations after 4 weeks showed equal results in both sockets however the PRF socket has the advantage of having well organized woven bone trabeculae and lined with osteoblast cells while in the TCP sample there was irregular woven bone trabeculae with various sizes and the absence of osteoblast cells.

Discussion

There is considerable demand for bone substitutes and bone augmentation materials in the dental and medical fields. Although freshly harvested autogenous cancellous marrow has always been the most biologically viable material, its clinical use is limited. This is due to the need for a second operation or surgical site and the potential complications arising from this and greater time of surgery and anesthesia [22]. There are a large number of biological and synthetic substitute bone materials which do not differ significantly in their clinical application and can be easily, cost-effectively, and efficiently used with minimum extra expense [22].

As the scope of implant dentistry widens, hard tissue augmentation is becoming more common. The previous "gold standard" for bone augmentation, autogenous bone, is limited in availability and restricted in harvesting due to increased peri- and postoperative complications [22].

Current research in bone tissue engineering aims to induce new functional bone regeneration via the synergistic combination of biomaterials, cells, and factor therapy [23]. But the ideal is to achieve high quality and quantity of bone after maturation through a process that will be less invasive.

The current study revealed the osteo-conductive potentials of both materials. Platelet-rich fibrin is a second generation platelet concentrate which can enhance both soft and hard tissue healing. The platelets and the growth factors they release are essential for regulating the cellular events that follow tissue damage. They adhere, aggregate, form a fibrin mesh, and subsequently release a large variety of growth factors and cytokines.

Calcium phosphates have a high affinity for proteins such as bone morphogenetic proteins (BMPs). The pores of the bioceramics have a filter effect and accumulate the growth factors from the surrounding body fluid inside of the micropores. Stem cell differentiation and ectopic bone formation can be stimulated by these bone replacement graft materials [24,25].

A synthetic graft, pure phase ß-tricalcium phosphate, has been documented in human and animal studies to be resorbed and replaced by vital bone in a 6 to 12 month time period. The predictability and effectiveness of this type of graft material in dental implant-related surgical applications has been demonstrated [22].

In the current study, both extractions sockets showed that bone grafting with PRF and TCP showed equal bone density. This implies that both materials are resorbable and osteogenic. Materials are resorbable if they break down by one of a number of mechanisms and can then be ingested by cells due to their chemical solubility. Only osteoclasts resorbable bone or other resorbable materials by releasing acids to dissolve the mineral portion. This action forms resorption lacunae [26] which dissolve the inorganic, calcium-phosphate components of the vital bone or graft. Materials degrade due to their physical characteristics, mechanical forces or they can be dissolved hydrolytically by fluids in the body milieu [27]. PRF induces cell proliferation of osteoblasts, periodontal ligament cells and growth factors during a 3-day culture period and suppressed oral epithelial cell growth. These cell type-specific actions may be beneficial for periodontal regeneration [27,28]. Diss., *et al*. (2008) in a 1 year prospective study on osteotome sinus floor elevation using Choukroun's platelet-rich fibrin grafting material clearly demonstrated that fibrin matrix of PRF directly promotes angiogenesis [29]. PRF when used as a membrane for guided tissue regeneration as a grafting material creates an improved space making effect which facilitates cell events that are favorable for periodontal regeneration leading to mineralized tissue formation. PRF is having an inherent osteoconductive and/or osteoinductive property which is beneficial for regeneration of the bone [29-33].

It was also realized in the current study that the examination the extraction site after 4 weeks showed equal results in both sockets however the PRF socket had the advantage of having well organized woven bone trabeculae and lined with osteoblast cells while in the TCP sample there was irregular woven bone trabeculae with various sizes and the absence of osteoblast cells. This demonstrated that PRF and TCP presented with 2 different methods of bone regeneration. It can be assumed that because of the growth factors in the PRF, the bone generation process is well organized with the presentation of osteoblasts and pluripotential cells as compared to TCP which serves as a scaffold for bone to form.

Conclusion

Though PRF and TCP generated bone of the same density, their mechanisms of bone formation was different. The PRF socket had the advantage of having well organized woven bone trabeculae and lined with osteoblast cells while in the TCP sample there was irregular woven bone trabeculae with various sizes and the absence of osteoblast cells, demonstrating the osteogenic potentials of PRF due to growth factors as compared to TCP that acts as a scaffold.

Conflict of Interest

AY and AMA declared they have no conflicts of interest individually or as a group.

Authors' Contributions

AY was involved in the concept of the study, clinical activities and follow-up, AMA was involve in the clinical activity and review of the manuscript.

Duplicated Publication

The manuscript is original, has not already been published in a journal and is not currently under consideration by another journal.

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