INTRODUCTION

Tooth extraction is one of the most widely performed procedures in dentistry. It has been historically well documented that this may induce significant dimensional changes of the alveolar ridge ***(Horowitz et al., 2012).***

Horizontal buccal bone resorption has been shown to reach as much as 56%, lingual bone resorption has been reported to be up to 30%, and the overall reduction in width of the horizontal ridge has been reported to reach up to 50%.With this horizontal ridge resorption, the alveolar housing assumes a more lingual/palatal position, with possible negative effects on esthetics, phonetics, and function ***(Schropp et al., 2003, Botticelli et al., 2004).***

Although the bone resorption continues over time, the most statistically significant loss of tissue contour occurs during the first month after tooth extraction and can average up to 3 to 5 mm in width by 6 months ***(Nevins et al., 2006).*** Placing a graft material into a socket has been one proposed method of preserving the natural tissue contours at extraction sites for possible reconstruction with an implant supported prosthesis ***(Tarnow et al., 2000).***

As implants serve as an aid for prosthetic devices, they need to be placed in a 3-dimensionally perfect location to achieve the appropriate esthetic, phonetic, and functional demands of the patient. This is particularly important in the esthetic zone where the gracile natural contours of the periodontium are quite evident and their absence can be devastating ***(Buser et al., 2004).*** To optimize implant positioning, placement of grafting materials has been advocated as either a combined procedure with a barrier membrane or in some instances with a barrier membrane alone to help to stabilize the blood clot ***(Nevins et al., 1992).***

Bone graft materials that are presently used in dental clinics are autogenous bone graft, allogenic bone graft, xenogenic bone graft, and alloplastic graft materials. According to bone-healing mechanisms, they can be categorized into materials that induce osteogenesis, osteoinduction, and osteoconduction. Among the many different types of bone graft materials, autogenous bones are the most ideal.They are capable of osteogenesis, osteoinduction, and osteoconduction. Their advantage is rapid healing time without immune rejection ***(Young et al., 2014).***

Nonetheless, their biggest shortcomings are that the harvest amount is limited, bone resorption after graft is unavoidable, and the second defect is generated in the donor area. Therefore, to overcome such shortcomings, allogenic bone graft and synthetic bone graft were developed and used in clinics, and efforts have been made to develop more ideal bone substitution materials ***(Young et al., 2014).***

It is well known that jaw bones, alveolar bone and teeth develop from cells of the neural crest and that many proteins are common to bone, dentin, and cementum ***(Donovan et al., 1993, Qin et al., 2002).*** It is therefore not surprising that dentin that forms more than 85% of tooth structure can serve as native bone grafting material. Interestingly, Schmidt-Schultz and Schultz found that intact growth factors are conserved even in the collagenous extracellular matrix of ancient human bone and teeth ***(Schmidt-Schultz et al., 2005).***

It is therefore evident that teeth become grafts that are slowly and gradually replaced by bone ***(Hasegawa et al., 2007).*** Currently, all extracted teeth are considered a clinical waste and therefore are simply discarded. Recently, several studies reported that extracted teeth from patients that undergo a process of cleaning, grinding, demineralization and sterilization is a very effective graft to fill alveolar bone defects of same patient ***(Kim et al., 2010, Kim et al., 2011, Murata et al., 2011).***

Teeth and jawbone have a high level of affinity, having similar chemical structure and composition. Therefore, it is proposed that extracted teeth should not be discarded anymore. Autogenous dentin is considered as the gold standard graft for socket preservation, bone augmentation in sinuses or filling bone defects ***(Kim et al., 2011, Murata et al., 2011, Kim et al., 2012).***

Alloplasts are synthetic materials that have been developed to replace human bone. They are biocompatible and are the most common type of graft materials utilized .They are osteoconductive materials ***(Hoexter, 2002).***

Beta-tricalcium phosphate (beta-TCP) is widely used as a biocompatible, resorbable and osteoconductive ceramic substitute to repair bone defects. It has also been proposed as a vehicle for growth factors that stimulate bone formation ***(Aybar et al., 2004, Byun et al., 2008).*** Various authors have reported on its capacity as a biomaterial for bone regeneration in animals and humans.

Among the different materials which were experimented and clinically examined for their potential application as regenerative tissue barriers, collagen appeared to be an optimal choice. It was considered to meet most requirements expected from bioabsorbable membranes ***(Haim et al., 2012).***

Collagen Type I polymerizes to form aggregates of fibers and bundles. Collagen is continuously remodeled in the body by degradation and synthesis. Type I collagen is degraded only by a specific enzyme - collagenase, and is resistant to any non-specific proteolytic degradation. Collagen biocompatibility, biodegradability and low immunogenicity render it advantageous for extensive application in pharmaceutical or biotechnological disciplines ***(Haim et al., 2012).***

The present study was conducted to compare and evaluate beta-tricalcium-phosphate with auto tooth graft versus beta-tri-calcium phosphate alone as socket preservation materials clinically, histologically and radiographically.

REVIEW OF LITERATURE

Tooth loss occurs due to various reasons, like periodontitis, trauma, periapical pathosis, or other pathological effects. After extraction, not only the tooth is lost, but also the alveolar socket passes through a great remodeling process, which has been accompanied by further bone loss ***(Maxmillian et al., 2015).***

Dental implants have been successfully used in the re-habilitation of partially and completely edentulous patients. However, the outcome of treatment with implants is no longer measured exclusively in terms of implant survival, but also by the long-term esthetic and functional success of the prosthesis ***(Froum et al., 2002, Buser et al., 2004, Darby et al., 2009).***

The successful esthetic and functional restoration of an implant depends on its optimal placement. This is influenced by its height and buccolingual position as well as by the alveolar ridge dimensions ***(Iasella et al., 2003).***

Traumatic tooth extraction causes bone loss and must therefore be prevented and the alveolar bone suffers atrophy after tooth extraction, which has been well documented. Thus, an understanding of the healing process of postextraction sites, including contour alterations caused by bone resorption and remodelling, is essential for obtaining functional and esthetically satisfactory prosthetic reconstructions ***(Schropp et al., 2003, Van der Weijden et al., 2009).***

The resorption and remodeling of the alveolar ridge after tooth removal is a natural healing phenomenon, which is physiologically undesirable and possibly inevitable and can negatively impact implant placement. This is particularly important in the anterior region of the maxilla, where a prominent root position is generally accompanied by an extremely fine and fragile vestibular wall that can be damaged during tooth extraction ***(Guarnieri et al., 2004, Nevins et al., 2006, Van der Weijden, 2009, Aimetti et al., 2009)*.**

Thus to meet the contemporary requirements of three-dimensional implant placement, the remaining alveolar ridge must be restored in most of the cases.

The alveolar process is a tooth-dependant tissue, and its architecture is oriented by the eruption axis, shape and eventual inclination of the teeth. The tooth, in turn, is anchored through fibrous bone in which the periodontal ligament fibers are inserted. This fibrous bone obviously loses its function and disappears after tooth removal, resulting in alveolar process atrophy ***(Araújo et al., 2005, Van der Weijden et al., 2009).***

After extraction, wound healing within sockets occurs through a sequence of processes, including hematoma and clotting, formation of granulation tissue, re-epithelialization, replacement of granulation tissue with connective tissue, and bone formation. In the first few minutes after tooth extraction, a blood clot consisting of erythrocytes and platelets that are trapped in a fibrous matrix forms within the extraction socket. Granulation tissue, a new connective tissue that is highly vascularized, then starts to form after forty eight hours and is completed by one week. The granulation tissue is totally replaced by connective tissue in about one month. Meanwhile, re-epithelialization starts after four days and is completed within six weeks, depending on the site of the extracted tooth. After six weeks, osteogenic cells from the apical aspects and the walls of the socket migrate into the developing granulation tissue, differentiate into mature osteoblasts, and initiate bone deposition that will be completed in 4–6 months ***(Pagni et al., 2012, Al Hezaimim et al., 2013).***

After tooth extraction, bone resorption occurs in two phases. In the first phase, the bundle bone (anchoring the tooth in the alveolar process through Sharpey’s fibers) is rapidly resorbed and replaced with newly formed immature woven bone. Woven bone then starts to be replaced with mature lamellar bone that fills with mature bone in about 180 days. In the second phase, the periosteal surface of the alveolar bone remodels through an interaction between osteoclastic resorption and osteoblastic formation, resulting in an overall horizontal and vertical tissue contraction ***(Tan et al., 2012, Wang et al., 2012, Pagni et al., 2012).***

The vertical linear extent of alveolar bone resorption occurs primarily during the first three–six months following extraction. The buccal plate of bone is the most affected because its crestal portion is composed of bundle bone only. It is also generally thinner than the lingual plate, about (0.8 mm) at the anterior teeth and (1.1 mm) at the premolar teeth ***(Schropp et al., 2003, Tan et al., 2012).***

The average of alveolar socket resorption is approximately (3.87 mm) loss of width and (1.67 to 2.03-mm) loss of height mostly in the first three months. This results in aesthetical problems and limits the convenience of dental implants and fixed partial dentures ***(Belser et al., 1998, Morton et al., 2004, Van der Weijden et al., 2009).***

There are multiple factors that affect ridge resorption as the depth of the extraction socket, thickness of mucosa, metabolic factors and functional loading. Preventing these factors alone does not stop ridge resorption sufficiently. Therefore, further techniques are necessary. In literature, many strategies like ultrasound therapy, sandwich osteotomy and distraction osteogenesis have been described to prevent or reconstruct ridge resorption ***(Atwood, 2001, Kerr et al., 2008, Ettl et al., 2010, Bormann et al., 2011, Laviv et al., 2014).***

None of them met the desired purpose of presenting a suitable ridge height and width for further implant or prosthetic treatment with a minimum effort. Alveolar socket preservation

(ASP) and alveolar ridge preservation (ARP) may seem to be a reliable alternative. In terms of definition, ASP is only used in completely contained extraction sockets which are filled with a bone substitute material (BSM) and/or sealed with membranes, whereas in ARP, damaged extraction sockets are also included. However, it should be clear that the term preservation does not mean that the alveolus original dimension can be kept. It is much more an attempt to keep the bone loss as low as possible ***(Maximillian et al., 2015).***

The last consensus “Osteology Consensus Report” stated the indications for “ARPs” as follows:

Maintenance of the existing soft and hard tissue envelope, maintenance of a stable ridge volume for optimizing functional and esthetic outcomes and simplification of treatment procedures subsequent to the ridge preservation ***(Hammerle et al., 2012).***

To minimize the alveolar bone loss to an acceptable level, several alveolar ridge preservation (ARP) procedures have been proposed. These have included the minimally traumatic extraction of a tooth, followed by immediate grafting of the extraction sockets using particulate bone grafts or substitutes, guided bone regeneration (GBR) with or without bone grafts or substitutes and a socket seal technique using different soft tissue graft materials ***(Wang et al., 2004, Mardas et al., 2010, Horvath et al., 2013, Araujo et al., 2015).***

The use of different grafting materials as an adjunct to GBR is based on the assumption that this material may be useful in inhibiting membrane or soft tissue graft collapse into the socket area and furthermore stimulating new bone formation through osteoinduction and osteoconduction ***(MacBeth et al., 2016).***

Various forms of materials are available for post-extraction ridge preservation. For optimal results, all grafts require an adequate blood supply, a form of mechanical support, and osteogenic cells supplied by the host, graft material or both ***(Klijn et al., 2010).***

Graft materials should have osteogenic, osteoinductive, or osteoconductive properties. Osteogenic grafts supply viable osteoblasts that form new bone e.g., (autogenous bone graft). Osteoinductive grafts stimulate the host mesenchymal cells to differentiate into osteoblasts that eventually form new bone e.g., (allografts). Osteoconductive grafts act as a scaffold or lattice for the surrounding cells to infiltrate and migrate through the graft e.g., (alloplasts) ***(Jamjoom et al., 2015).***

- ***Autogenous bone graft***

Autogenous bone is transferred from one position to another within the same individual. Autografts are biocompatible and have the potential to form new bone through osteogenesis, osteoinduction, and osteoconduction. On the other hand, they have disadvantages as limited amount of material, donor site morbidity, unpredictable bone quality, and post-operative discomfort ***(Vos et al., 2009, Jamjoom et al., 2015).***

Autogenous grafts can be cortical, cancellous, or cortico-cancellous. Cancellous autogenous bone is generally preferred, because it is rapidly revascularized and integrated into the recipient site**.** Autogenous bone can be obtained from intra-oral or extra-oral sites and can be used in block or particulate forms. Autogenous bone can be used alone or combined with other bone substitutes to form composite grafts ***(Aimetti et al., 2009, Al Ghamdi et al., 2010, Porrini et al., 2011, Hammerle et al., 2012)***.

According to Maxmillian et al in a meta-analysis in 2015, two randomized clinical trials compared twenty five autograft- filled sockets versus twenty five empty ones and found more vital bone in sockets grafted with autografts after six months ***(Pinho et al., 2006, Pelegrine et al., 2010, Maxmillan et al. 2015)***.

- ***Bone substitutes***

Several types of bone substitutes are commercially available, including allografts (from genetically similar members of the same species), xenografts (from other species), and alloplasts (of synthetic origin) ***(Guarnieri, et al., 2005, Torres et al., 2010, Ten et al., 2011).***

Bone substitutes ideally should be osteogenic and biocompatible, completely resorbable, non-antigenic, non-carcinogenic, inexpensive, and have no risk of disease transmission. They should also be space-maintaining, and have a similar composition, particle size and resorption rate as human bone ***(Darby et al., 2011, Shue et al., 2012).*** They include:

- ***Allografts***

Allografts can be fresh-frozen, freeze-dried, or demineralized freeze-dried. The use of freeze-dried bone allografts (FDBA) and demineralized freeze-dried bone allografts (DFDBA) has minimized the problem of immunogenicity that was associated with fresh-frozen bone. They are the most common allografts used currently for ridge preservation ***(Al Ghamdi et al., 2010).***

FDBA revascularization occurs through integration /replacement (creeping substitution) at the recipient site and the formation of connective tissue areas. Small particles of the allograft may remain for several months to a year before they are completely resorbed. DFDBA also showed more vital bone and less residual grafting material compared to FDBA when placed in extraction sockets 19 weeks after extraction ***(Eskow, 2014).***

The extent of allograft osteoinductivity depends on the donor age and the amount of bone morphogenetic proteins (BMPs) present in the graft. Grafts obtained from younger donors generally have more BMPs and are more osteoinductive. FDBA and DFDBA are widely used for regenerative therapy and ridge preservation ***(Yukna et al., 2005, Al Ghamdi et al., 2010).***

Maxmillan et al in his meta-analysis in 2015 included three articles where allografts were used to treat thirty two sockets. ***Froum et al. in (2002)*** compared bioactive glass to DFDBA and empty sockets at six and eight months from extraction. The differences in percentage of vital bone were not statistically significant among the 3 treatment groups. Another study in 2003 compared FDBA and collagen membrane versus extraction alone and concluded that ridge preservation limited the loss of hard tissue ridge width and provided a gain in hard tissue ridge height when compared to extraction alone. In 2012 a clinical, radiographic, micro-computed tomography, and histologic study evaluated dimensional changes and new bone formation of the alveolar ridge. They found that the percentage of new bone was not statistically significant between either the test or control sites, using either microCT or histologic analyses. Studies thus left us with inconclusive data **(*Froum et al., 2002, Iasella et al., 2003, Brownfield et al., 2012*).**

- ***Xenografts***

Xenografts are obtained from a variety of sources, including bovine, porcine, equine, and coralline, and are biocompatible and structurally similar to human bone Xenografts are osteoconductive and less frequently associated with the formation of interposition areas of connective tissue, but are not osteoinductive in humans ***(Al Ghamdi et al., 2010).*** Xenografts originally were used to treat infrabony periodontal defects and generally resulted in new attachment and cementum formation when compared to ungrafted sites.

Bovine xenografts are the most commonly used. They contain similar hydroxyapatite content to the human bone, which allows the graft to revascularize and be replaced by new human bone. Bovine bone is associated with 20%–40% retention of the graft after six months as well as after three years, following placement ***(Al Ghamdi et al., 2010, Rodella et al., 2011).***

The slow substitution rate allows long-term space maintenance. Other histological studies show good integration of bovine xenograft particles with newly formed bone filling the interparticulate space, forming direct contacts with the grafting material. Methods to reduce antigenicity are similar to those used to process allografts ***(Darby et al., 2011, Porrini et al., 2011).***