INTRODUCTION

In adults, teeth get lost for various reasons, like periodontal disease, trauma, periapical lesions, or other pathological effects. After extraction, not only the tooth is lost, but also the alveolar socket passes a huge remodeling process, which has been associated with further bone loss ***(Wang et al., 2012)***.

A significant dimensional change occurs during the healing phase of extracted sockets. Bone remodeling commences and continues for several months, with most changes occurring in the first three months ***(Schropp et al., 2003)***. Post-extraction alveolar bone changes have been estimated to cause 50% reduction in the bucco-lingual width of the alveolar bone, and a further loss in height has also been reported ***(Camargo et al., 2000; Iasella et al., 2003)***.

The overall alveolar changes following tooth extraction may compromise the prosthodontic rehabilitation using tooth-supported fixed or removable prostheses, as well as implant-supported prostheses ***(Atieh et al., 2015)***.

Alveolar ridge preservation (ARP) is defined as the procedure of arresting or minimizing the alveolar ridge resorption following tooth extraction for future prosthodontic treatment including placement of dental implants ***(Atieh et al., 2015)***.

ARP techniques include the use of grafting materials of human, animal or synthetic origin, with or without the use of barrier membranes, to further optimize the functional and aesthetic restoration of dental implants. The grafting materials include: particulate autogenous chips, allografts, xenografts, and alloplasts ***(Araujo et al., 2010; Araujo, 2011)***.

The literature describes a variety of membranes for covering extraction sockets and preserving alveolar ridges. Barrier membranes can be classified into two main categories: the non-resorbable and the resorbable membranes. The former is characterized by its larger bone fill and favorable marginal tissue response provided that the membrane is not exposed (e.g. expanded polytetrafluoroethylene (ePTFE)). On the other hand, resorbable membranes do not require a second surgery and are characterized by significant improvement in soft tissue healing, with minimal tissue reaction to membrane exposure (e.g. bovine and porcine collagen membranes) ***(Iasella et al., 2003)***.

Autogenous bone grafts have been always the gold standard owing to their osteogenic, osteoinductive and osteoconductive properties. However, they had some drawback. The most important of which are donor site morbidity and potential resorption. For that reason, many researchers started to think of extracted human teeth as a source for bone grafts, especially that they have similar chemical composition to bone. Also, teeth and maxillofacial bones share a similar neural crest embryologic origin ***(Kim et al., 2010 (a))***.

Autogenous tooth graft material consists of 55% inorganic and 45% organic substances. The inorganic content is known to have an osteoconductive property which makes it a biocompatible bone graft material. The organic matrix of dentine is predominated by a fibrous network of type I collagen that constitutes 90% of this content. The rest 10% of the dentin matrix is formed by non-collagenous proteins which are involved in bone calcification, and growth factors, including bone morphogenetic proteins (BMP), LIM mineralization protein 1 and insulin-like growth factors. This gives teeth an osteoinductive property ***(Kim et al., 2010 (a); Gual et al.,2018)***.

Autogenous fresh tooth graft that is prepared at the chairside after extractions is considered as a highly useful grafting alternative for socket preservation, bone augmentation in sinuses or filling of bone defects, in patients having non-restorable teeth indicated for extraction ***(Melek and said, 2017)***. The use of grafting material in combination to collagen membranes seems to improve the clinical outcomes ***(Bunyaratavej and Wang, 2001)***.

The present study was conducted to evaluate autogenous tooth graft as a ridge preservation material clinically, radiographically and histologically.

REVIEW OF LITERATURE

Loss of alveolar bone may be attributed to a variety of factors, such as endodontic pathology, periodontitis, facial trauma and aggressive maneuvers during extractions. Millions of teeth are still extracted annually. 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 ***(Tassos, 2007; Jamjoom et al., 2015)***.

Alveolar ridge resorption that occurs following tooth extraction may complicate the subsequent use of dental implants and common prosthetics. Success of dental implant placement (especially anterior teeth region) is determined by fulfilled complex requirements such as sufficient height and width of alveolar bone ridge and an adequate thickness of soft tissue covering the bone. Satisfactory parameters allow a specialist to place an implant in an ideal position in accordance with adjacent teeth. Facial bone surrounding the implant must be at least of 2 mm thickness, to prevent the vertical alveolar bone resorption ***(Marius et al., 2012)***.

Changes of alveolar bone ridge after teeth extraction are unavoidable as documented in studying animal and human models. After the healing event, the crest of the residual ridge had shifted lingually when compared with the original position of the teeth before extraction and from the lateral aspect, the residual ridge often forms a concavity. The bigger the damage to the facial wall due to trauma or disease, the bigger the deformation of the contours ***(Schropp et al., 2003; Marius et al., 2012)***.

After tooth extraction, the entire socket is filled by blood clot which is formed within 24 hours conclusively. This clot acts as a physical matrix which directs the movement of cells, as well as growth factors. Neutrophils and macrophages enter the wound site and digest bacteria and tissue debris to sterilize the wound. They release cytokines and growth factors that will induce and amplify the migration of mesenchymal cells and their activity within the coagulum ***(Lin et al., 1994)***.

Within 2 to 3 days, the clot contracts and starts to break down and granulation tissue starts to form. After 4 to 5 days the granulation tissue covers alveolar bone ridge, and the epithelium proliferates along the soft tissue periphery covering this granulation tissue. By the end of the 1^{st} week, osteoid is evident at the apical portion of the socket as uncalcified bone spicules and the vascular network is also formed ***(Schropp et al., 2003)***.

After 3 weeks the alveolus is filled with connective tissue, while osteoid begins to mineralize, and the socket surface is covered by epithelium. 6 weeks later, trabecular bone formation is observed while bone deposition in the socket becomes evident after two months. Bone deposition is decelerating after 4 to 6 months ***(Vanchit et al., 2007; Chen et al., 2008; Marius et al., 2012)***.

Regarding extra alveolar changes after extraction, when a tooth is extracted – periodontium is destroyed and consequently resorption of compact bone is apparent. In addition, resorption increases in case of mucoperiosteal flap elevation. One week after tooth extraction, a significant increase in osteoclasts quantity on the inner and outer side of the alveolar walls was observed. Two weeks later, osteoclasts were present in the exposed area of the alveolar ridge, the bundle bone replaced by immature bone intermittently ***(Lindhe et al., 2003; Fickl et al., 2008 a; Marius et al., 2012)***.

During the four-week period of monitoring, osteoclasts in the buccal site and alveolar bone ridge area remained, immature bone was replaced by trabecular one. After 8 weeks, the alveolar socket was covered by compact bone. External alveolar walls and aleveolar crest were still under resorption ***(Lindhe et al., 2003)***.

During the 12 months period after tooth extraction the width of the alveolar ridge was decreased by 50 percent, two-thirds of this width reduction occurs during the first 3 months. During the first year after extraction, bone resorption was 10 times greater than the subsequent years ***(Van der Weijden et al., 2009; Tan et al., 2012)***.

Socket morphology following tooth extraction and the degree of soft tissue recession are of the primary factors determining which treatment to select in the aesthetic zone. The clinical presentation of alveolar defects seen immediately following tooth removal varies from simple to complex. This evaluation can be accurately made immediately following extraction, since damage often occurs during the process of tooth removal. A classification of the extraction defect, as it presents immediately following tooth removal associated with dental implant treatment recommendations, would be beneficial for the clinician in establishing the most appropriate treatment plan ***(Nicholas et al., 2005)***.

Based on the hard- and soft-tissue topography, extraction sockets can be classified as follows:

- Type I: The facial soft tissue and buccal plate of bone are at normal levels in relation to the cementoenamel junction of the pre-existed tooth and remain intact post extraction.
- Type II: Facial soft tissue is present, but the buccal plate is partially missing following extraction of the tooth.
- Type III: The facial soft tissue and the buccal plate of bone are both markedly reduced after tooth extraction ***(Elian et al., 2007)***.

Historically, the first therapeutic attempts to prevent alveolar ridge resorption were performed by root retention, with the primary goal of maximizing the stability of removable prosthesis. Nevertheless, root retention is not always feasible because of fracture, caries or other reasons. Alveolar ridge preservation via “socket grafting” emerged in the mid-1980s as a therapeutic alternative to root submergence. Filling the space left by the extracted tooth with a biomaterial would emulate a “root retention effect” contribute to bone preservation. This approach gained popularity over the years because of its conceptual attractiveness and technical simplicity ***(Avila et al., 2014)***.

Various surgical procedures, have been introduced aiming both to maintain an ideal ridge profile in esthetic sites, and to prevent alveolar ridge collapse, preserving adequate dimensions of bone to facilitate correct implant placement ***(Darby et al., 2008; Valeria et al., 2013)***.

Different terms were used to describe this procedure, such as ’socket preservation’, ’socket augmentation’, ’socket grafting’, ’ridge preservation’, ’alveolar bone grafting’ and ’alveolar augmentation’, which is defined by the Glossary of Prosthodontic Terms as “any surgical procedure employed to alter the contour of the residual alveolar ridge” ***(Academy of Prosthodontics, 2005; Atieh et al., 2015)***.

According to the Osteology Consensus Group 2011, alveolar ridge preservation is a general term for interventions that aim to preserve the ridge volume within the envelope existing at the time of extraction, to simplify the subsequent treatment procedures ***(Christoph et al., 2011)***.

Atraumatic tooth extraction is very important for preservation of alveolar bone volume and surrounding soft tissues. Many techniques and tools have been proposed for minimally invasive tooth removal, including the use of periotomes, Physics Forceps, Ogram’s system technique, Easy X-TRAC system and Powertomes ***(Bartee, 2001; Marius et al., 2012)***. ***Patil, et al***. described atraumatic extraction technique starting with circumferential rotation luxating movements being used instead of the conventional facial-lingual movements. These movements stretch the periodontal ligament and stimulate the release of lysosomal enzymes in the periodontal ligament space, which dissolve the periodontal ligament fibers and create a hydrolic pressure in the ligament, thus aids in loosing of the tooth ***(Patil et al., 2012)***.

After tooth extraction, blood clot has no mechanical stability. It can be washed out with water or damaged mechanically which can complicate alveolar healing process. Stability of the blood clot can be done with the following material combinations: a) surgical suture; b) collagen; c) polylactide/polyglycolide gel/sponge; d) isobutyl cyanoacrylate; e) temporary crown above the extraction socket ***(Serino et al., 2007; Chen et al., 2008; Marius et al., 2012)***.

Some studies stated that remodeling cannot be avoided with ridge preservation techniques, but they concluded that ridge preservation has advantage over no treatment due to less horizontal and vertical bone loss ***(Araujo et al., 2015; Passoni et al., 2016)***. In a systematic review, ***Vittorini et al***. noted that following tooth extraction, it is preferable to perform ridge preservation at esthetic areas where the buccal bone thickness is less than 1.5 to 2 mm; when several teeth are extracted or when anatomical structures such as the maxillary sinus and mandibular canal are in immediate proximity ***(Vittorini et al., 2013)***.

Several approaches have been described for preventing the socket wall alterations caused by tooth extraction: implant placement directly after extraction; positioning of the implant on the palatal/lingual wall ("palatal approach"); performing the surgery using the flapless technique to maintain vascularization; and using membranes alone or with bone grafts to maintain the dimension of the ridge by socket augmentation. Bone grafts such as autografts, allografts, xenografts, and alloplasts can used for ridge preservation. Growth factors, also can be used to enhance biologic outcome. All grafts require an adequate blood supply, a form of mechanical support, and osteogenic cells supplied by the host, graft material or both ***(Kim et al., 2010 (a); Jamjoom et al., 2015)***.

Implant placement post extraction of a single tooth in the esthetic zone is a frequent indication of implant therapy, and the clinician has four options to choose from: 1st Immediate implant placement at the same day of extraction; 2nd early implant placement within 4–8 weeks; 3rd delayed implant placement within 12–16 weeks; 4th late implant placement after complete bone healing more than 6 months. Today, all four options can be used depending on the clinical and radiographic preoperative analysis to assess the patients risk profile. However, these four options are not used to the same extent and frequency ***(Brugger et al., 2015)***.

The primary objective of implant therapy in the esthetic zone is an optimal esthetic treatment outcome with high predictability and a low risk of complication such as recession ***(Buser et al., 2009)***. Esthetic outcomes in sites with "post extraction implant placement" must be viewed from a mid- to long-term perspective, since the stability of the facial hard and soft tissues is the most important. Secondary objectives include the least number of surgical interventions, the least possible pain and morbidity for the patient, a short overall healing and treatment period, and finally to deliver the treatment with good cost effectiveness ***(Cosyn et al., 2016)***.

In the past 15 years, major efforts have been made to improve aspects of these secondary objectives, to make implant therapy more attractive for patients. However, these secondary objectives should not jeopardize the primary objectives and cause reduced esthetic outcomes or increased rates of complications ***(Bornstein et al., 2015)***.

Immediate implant placement is one measure that used to preserve the ridge and to enhance the esthetic outcomes. It considered a complex procedure and should only be performed by experienced clinicians on ideal anatomic conditions. This includes (i) a fully intact facial bone wall at the extraction site with a thick wall phenotype ($\geq$ 2 mm), (ii) a thick gingival biotype, (iii) no acute infection at the extraction site, and (iv) a sufficient volume of bone apical and palatal of the extraction site to allow implant insertion in a correct 3D position with sufficient primary stability. When these ideal conditions are not met, the international team for implantology (ITI) recommends early implant placement after 4-8 weeks of soft tissue healing. In cases where it is anticipated that primary stability cannot be achieved after 4–8 weeks, the post-extraction healing period should be extended to allow partial bone healing ***(Daniel et al., 2017)***.

Ideally, immediate implant placement should be performed using flapless approach to avoid an open-flap procedure. Flapless implant placement has been shown to be associated with less recession of the mid-facial mucosa compared with open-flap immediate implant placement. This offers the least possible tissue morbidity for the patient and reduced number of post-surgical visits ***(Furhauser et al., 2015)***.

Socket-shield technique (SST) retains partial buccal root fragment after extraction, preserving periodontal vascularization, cementum bundle bone and the buccal bone wall. This technique has several advantages: there is no added cost for materials, comorbidity is reduced, it can be applied in the presence of endodontic apical pathology, and reduced surgical intervention ***(Hurzeler et al., 2010; Chen & Pan, 2013)***.

Socket-shield technique might reduce alveolar bone resorption and help to avoid soft-tissue or hard-tissue grafting. However, SST is a sensitive technique that needs extensive planning. Its success greatly depends on the operator's skills and ability to create a satisfying and long-lasting rehabilitation ***(Reza et al., 2017)***.

A wide range of membranes has been designed for various clinical applications, each possessing distinct advantages and disadvantages. Barrier membranes should fulfil some fundamental requirements: Biocompatibility; Space-making; Cell-occlusiveness; Mechanical strength and Degradability ***(Zhang et al., 2013)***.

Barrier membranes classified into two main categories: the non-resorbable and the resorbable membranes. Non-resorbable membranes include expanded, high-density and Titanium-reinforced polytetrafluoroethylene and titanium mesh (Ti-mesh) ***(Rakhmatia et al., 2013)***.

Non-resorbable membranes have a more predictable profile during the healing process for their adequate mechanical strength, they are easy to handle, remain intact until removal, allow greater bone fill with minimal tissue response if membrane not exposed, but the requirement of a second surgical intervention to remove the barrier 4 to 6 weeks after implantation is a significant drawback. As this second surgery, may injure and/or compromise the obtained regenerated tissue, since it is known that flap elevation results in a certain amount of crestal resorption of the alveolar bone. Furthermore, the use of non-resorbable membranes involves extra surgical times, which leads to increased costs and patient discomfort ***(Tassos et al., 2007; Gentile et al., 2011)***.

It has been shown that extraction sockets treated with expanded polytetrafluoroethylene (ePTFE) membranes presented with significantly greater dimensions of the alveolar ridge when compared to sites not treated with a membrane ***(Gentile et al., 2011)***.

On the other hand**,** resorbable membranes such as collagen membranes, permit a single-step procedure, thus alleviating patient discomfort and costs from a second procedure, avoiding the risk of additional morbidity and tissue damage and does not have to be removed if exposed. The main disadvantage of resorbable membranes is the unpredictable resorption time and the degree of degradation, which directly affects bone formation ***(Tassos et al., 2007; Thoma et al., 2009)***.

Collagen is the principal component of connective tissue that provides structural support for tissues throughout the body**.** Collagen is a hemostatic agent, it possesses the ability to stimulate platelet attachment and to enhance fibrin linkage, which may assist initial clot formation and stabilization, leading to enhanced regeneration. In addition, collagen is chemotactic for fibroblasts in vitro. This property could possibly enhance cell migration in vivo ***(Marinucci et al., 2001)***. Resorbable membranes have shown to be successful in guided tissue regeneration (GTR) around natural teeth and in guided bone regeneration (GBR) around implants ***(Bunyaratavej et al., 2001; Wang et al., 2001)***.

The average loss of alveolar height and width in sockets that were left to heal with only a membrane covering them was less than the average loss in sockets that healed naturally. In addition, the quality of the bone in sockets that have healed in the presence of a barrier membrane is excellent for implant placement ***(Carmagnola et al., 2003; Tassos et al., 2007)***. A study by ***Pangi et al***. has shown that barrier membranes minimize alveolar bone resorption regardless of the use of additional grafting material ***(Pagni et al., 2012)***.

Augmentation of extraction sites with graft materials tends to reduce bone loss, most likely through maintenance of physical stimulation to the surrounding bone. Various types of bone grafting materials have been suggested for this purpose, and show predictable results ***(Iasella et al., 2003)***.