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WiFi Mesh for Guided Bone Regeneration: A Literature Review

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Abstract: ***GBR (Guided Bone Regeneration) related to a titanium implant establishment is generally utilized. A focal idea of GBR is the application of a layer to prevent tissues related non - osteogenic potential from meddling during bone regeneration. Membrane materials have an assortment of attributes that can be changed. These GBR qualities are expected to furnish the tissue with the best membrane function and mechanical assistance during bone regeneration. Titanium reinforced d - PTFE membrane has sublime mechanical and functional properties for GBR treatment, and this review will focus on their new viability in preliminaries.***

Keywords: Guided Bone Regenration, Wifi Mesh, Titanium reinforced d - PTFE, e - PTFE

1. Introduction

Implant dentistry has improved the individual's requirement of replacing teeth. For an implant therapy to be effective, the patient's alveolar bone should be sufficient to hold the implant and to give acceptable clinical and functional results. Nonetheless, such measures are not met by numerous patients in routine clinical practice [1]. Bone deficiency could be credited to numerous reasons including tooth extraction, trauma, debilitating illnesses, poor endodontic treatment, periodontal weakening, and tumors [2]. Following extraction of tooth, the typical healing occurs roughly over 40 days, beginning with formation of clot and finishing in an attachment loaded up with bone which is shielded by connective tissue & epithelium [3]. Complete protection and reclamation of the original bone volume after tissue regeneration would be ideal for future positioning of implant. Sadly, this is generally not the situation. Indeed, without any further therapy bone resorption at the crest is natural and inevitable which can prompt major dimensional changes in alveolar bone. These progressions range from a normal vertical bone deficiency of 1.5 - 2 mm and a normal level horizontal alveolar bone deficiency of 40 to 50 percent over 6 - 12 months of healing [4]. During the first 3 months, several dimensional shifts take place [2]and will lead for a further 11 per cent in the next 5 years of volumetric bone loss. [5]. In 2 - 3 years, Ashman found that tooth extraction caused a reduction of bone width & height of around 40 - 60%, respectively [6]. The horizontal axis is more commonly resorbed than the vertical plane, resulting in greater reduction of alveolar diameter [7]. In any of these events grafting of bone is imperative. There are currently many materials and surgical procedures available for the horizontal or vertical increase of specific alveolar bone, e. g. transposition of inferior alveolar nerve, osteodistraction, inlay &onlay grafting, and guided bone regeneration (GBR) techniques [8]. However, GBR is a common technique that produces satisfactory results using numerous barrier membrane elements. The aim of this literature review is to analyse and give a description of Guided Bone Regeneration, its principle, mechanism and Wifi Mesh (Cowell Medi Co Ltd), its indication of usage, advantages & drawbacks.

Definition and Principles of GBR

GBR is described as “a surgical procedure that augments alveolar bone volume in areas designated for future implant placement or around previously placed implants” according to the American Academy of Periodontology [9]The fundamental theory of GBR relies on guided tissue regeneration [10]. GTR, moreover, includes bone, cementum & periodontal ligament regeneration to produce a new periodontal system while GBR calls for enhanced and

complex bone formation [11]. In accordance with this idea, osseous defects can regenerate through the use of occlusive barrier membranes which secure the blood clot dynamically, develops room and exclude it from the surrounding tissue non - bone forming cells. This increases the pluripotential & osteogeniccell populations from the parent bone in order to replenish bone defects [12]. The amount of osteogenesis from the neighbouring bony margin must surpass the amount of fibrogenesis in the surrounding soft tissue to restore the bone defect. [13]. In a therapeutic case, the effectiveness of the ridge expansion is also difficult to predict. Four values must be fulfilled to ensure effective GBR: connective tissue and epithelium elimination, maintenance of space in the area of defect, maintaining the integrity of fibrin clot and primary closure of the wound [14].

Bone regeneration exhibits a particular series of events following GBR procedures. In the initial period of 24 hours subsequent to bone - grafting, the area generated by the graft material/ barrier is filled with the blood clot that generates growth factors which further attracts macrophages & neutrophils (e. g. platelet - based growth - factor). The clot is absorbed and substituted with granulation tissue rich in nutrient vessels which are freshly developed. Mesenchymal stem cells & nutrients capable to formosteogenic substances can be transferred via these vessels and help the development of osteoid. Osteoid undergoes mineralization and gets converted to woven bone, that subsequently provides a framework for the lamellar bone [15] [16].

Barrier Membranes

E - PTFE (Expanded polytetrafluoroethylene) was first formulated in 1969 & became a staple in the early 90's for bone regeneration [17]. PTFE is a chemically and biologically inert polymer made up of a carbon backbone covalently bonded to a standardized fluorine sheath that can be manufactured and crafted into array of forms and can withstand enzymatic and microbiological assault. [18]. The membrane e - PTFE is fabricated into the configuration of the material with pores between 5 to 20 µm. The big downside of e - PTFE may be an initial bacterial infection, affecting regeneration outcomes [19]. Soft tissue covering or primary closure is traditionally needed for e - PTFE & resorbable membranes to avoid soft tissue regeneration, bacterial invasion, membrane displacement, early membrane breakdown, and exposure of underlying graft. [20]. In 1993, the most prominent Cytoplast®, d - PTFE (high density PTFE) with a negligible pore size of less than 0.3 µm, was created to solve this issue. Animal and human trials have shown the improved effectiveness of d - PTFE membranes in guided tissue regeneration. [21] [22]. In any event, when the membrane is opened to the oral cavity, microscopic organisms is prohibited by it while oxygen dissemination and transfer of molecules across the layer is as yet conceivable [20]. Titanium, in contrast to PTFE membranes, is a non - resorbable substance that can be used for alveolar bone reconstruction. Boyne et al. introduced a titanium membrane for the restoration of significant osseous defects in 1969. [23]. Due to its durability and rigidity, low density and resulting low weight, high temperature - resistance and corrosion - resistance, titanium has been widely used in various operational purposes. [24] [25]. The key benefits of titanium mesh are that the room to be regenerated is maintained and preserved and is lightweight and flexible [26] [27]. As titanium - reinforced e - PTFE or d - PTFE, the e - PTFE and d - PTFE membranes are also available. The incorporated titanium frame helps the membrane to adapt without bouncing back to a number of defects and offers exceptional stability in large, and in those complicated osseous defects where complexity of maintaining the space is high.

Many kinds of materials and their forms were examined in order to identify the most powerful form of barrier membrane for GBR. As a result, the Wifi - shaped titanium reinforced PTFE membrane performed best in inducing osteoconductive bone surface regeneration by interacting with neighbouring osteogenic stem cells. This phenomenon is analogous to Wifi, with a mesh - like contact network that extends greatly into empty space and a form that resembles the Wifi sign on the titanium of the product. The product was given the name "Wifi - Mesh" because of the phenomenon and its nature (Figure 1). Its indications for use includes all GBR - required cases, especially anterior sections that need a specific form and defects with little residual bone, as well as the prevention of marginal bone resorption, which is the most critical aspect of implant therapy, by preserving the vertical and horizontal volume of the alveolar bone.

Figure 1: Wifi Mesh
(Source: www.googleimages. com/wifimesh)

Advantages of Wifi Mesh:

Infections caused by bacterial adhesion are avoided, particularly at early exposure due to non - porous structure, simplistic removal process and thin consistency makes the second surgery easy and very convenient for patients and clinicians, practically transparent surface provides very predictable solution and is simple to examine underlying tissue and exceptionally cost effective, safe for more than 6 weeks, provide shape - keeping property due to titanium incorporation against external force.

Disadvantages of Wifi Mesh:

One major downside to these Wifi Mesh is the need for an additional surgery for its removal. While the elevation of the flap induces certain crestal bone resorption, causing unpleasantness increased patients' costs and the possibility of some of the regenerated bone being lost.

2. Discussion

A vertical bone deformity is portrayed in dentistry as an uneven resorption of 2 mm or a greater amount of the interdental bone apical to the crest of alveolar bone on one side. The maxilla & mandible have a right - left isotropic pattern of periodontal destruction, although it is more

frequent in the posterior than the anterior. [28]. Both the predominance and seriousness of vertical bone loss accelerates with age, and when become expansive, they can bargain the satisfactory situation of dental implant placement [29]. In such cases, the dental specialist is confronted with the problem of whether to expand the bone or to utilize short implants. At this time, various techniques are used to enhance the maxillary and mandibular alveolus. [8]. Guidedbone regeneration, onlay bone, distraction osteogenesis of alveolus, and the application of interpositional bone grafts are among some of the methods used to augment bone [30]. A long - lasting membrane is used in conventional GBR procedures to separate the area and secure the clot. The membrane serves as a scaffold for osteoprogenitor cells and blood vessels to expand, as well as a physical barrier to epithelial and connective cell invasion from the soft tissues. [31]. Simion in 2007 [32]demonstrated that GBR surgeries involving a 50: 50 combination of autogenous & bovine deproteinized bone particles below a membrane of e - PTFE were effective for treating vertical atrophies in both single - stage &two - stage surgeries, as well as concurrent implant placement.

The first exclusive report on d - PTFE was reported by Carbonell et al. [33]in which the author concluded that the d - PTFE membrane was a promising candidate as a barrier membrane. The thickness of d - PTFE membranes varies from 0.13 to 0.25mm, and the low porosity varies from 0.2 to 0.3mm. On contrary, e - PTFE has a higher porosity (5–30mm) but a similar thickness compared with d - PTFE. The reduced pore size and minor bacterial infiltration enables the d - PTFE membrane to be widely used [34]. Krauser presented a case of extractions with immediate implants plus a subsequent GBR using only n - PTFE, showing no histological tissue ingrowthin the retrieved membrane and dense connective tissue with some mineralized tissue in the superficial regenerated tissue [35]. However, other authors recommend prolonged membrane retention (4–6 weeks), showing similar results in terms of regeneration: an underlying well - consolidated layer of osteoid tissue at 4–6 weeks and secondary epithelialization occurring after membrane removal over the dense connective tissue 10–14 days later. Besides PTFE membranes, titanium is another nonresorbable material applicable for dental bone repair. In 1969, Boyne et al. [23]inaugurated a mesh from titanium. Titanium mesh (Ti - mesh) has excellent mechanical properties for the stabilization of bone grafts beneath the membrane. Its rigidity provides extensive space maintenance and prevents contour collapse; its elasticity prevents mucosal compression; its stability prevents graft displacement; and its plasticity permits bending, contouring, and adaptation to any unique bony defect [36]. Various studies have shown that Ti - mesh maintains space with a higher degree of predictably, even in cases with a large bony cavity. In addition, it is believed that the smooth surface of Ti - mesh makes it less susceptible to bacterial contamination than resorbable material [37]. However, the stiffness of the Ti - mesh also lends itself to causing an increased number of exposures, such as mechanical irritation to the mucosal flaps [38]. In addition, the sharp edges, caused by cutting, trimming, and bending of titanium mesh, might be responsible for exposure of titanium barriers [39]. Hence to overcome these limitations Ti reinforced d - PTFE was developed with mesh - like communication network that spreads widely into empty space and the shape of the titanium of the product looks like the Wifi symbol which result in inducing osteoconductive bone surface regeneration by communicating with adjacent bonestem cells. The titanium frame used has very little or no memory so it may be formed to desired shape and will remain in the same state until mechanically altered. For this reason screws or tacks are not always necessary if stability can be obtained by simply tucking the membrane. It is recommended that the membrane stays in place for 3 - 4 weeks. This provides sufficient time for blood clot to form, graft material to consolidate and osseous tissue to begin forming under the membrane. It can also be used as open membrane application when proper soft tissue closure is not achieved.

3. Conclusion

Within the limits of the present review, the following conclusions can be drawn:

1) The Wifi mesh may be a promising barrier, however the evidence is limited.
2) Satisfactory results can be achieved in ‘open GBR procedures’ using Wifi mesh.
3) The minimum membrane retention time in GBR procedures ranges from 3 weeks to a maximum of 6 weeks, depending on the size of the defect and the grafting material used.
4) Considering the potential benefit they offer, Wifi mesh is a favorable candidate for GBR. However, the existing evidence regarding its use for GBR is limited. This necessitates effecting more clinical studies and RCTs with histological and radiographic assessment.

4. Acknowledgement

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5. Conflicts of Interest

None to declare

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