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Tissue regeneration for periodontal diseases

A Project Submitted to
The College of Dentistry, University of Baghdad, Department of periodontic in Partial Fulfillment for the Bachelor of Dental Surgery

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Certification of the Supervisor

I certify that this project entitled **Tissue regeneration for periodontal diseases** was prepared by **Ahmed Manhal Sami** under my supervision at the College of Dentistry/University of Baghdad in partial fulfilment of the graduation requirements for the Bachelor degree in dentistry.

Supervisor's name

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Date

April,2023

Dedication

I dedicate this project to the warmest embrace, the greatest bond and the owner of the greatest merit to our country and our origins to (Iraq).

To those who have reached this stage thanks to them, their fatigue, their constant struggle, and their constant support, to our parents and family, our teachers.

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In the end, I thank my family for all the support they have provided throughout the years of studying,

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1.CEJ	Cemento_enamel junction
2.GTR	Guided tissue regeneration
3.FDBA	Freeze dry bone allograft
4.DFDBA	Demineralized freeze dry bone allograft
5.EMD	Enamel matrix derivative
6.BMPs	Bone matrix proteins

Chapter one

1.1 INTRODUCTION

The periodontium is a highly hierarchical organ consisting of intercalated soft (gingival and periodontal ligament) and hard (cementum and alveolar bone) tissues that mechanically support the teeth and play an important role in transmittingthe mechanical forces experienced during mastication.Periodontitis is a inflammatory condition of the periodontium that is characterized by irreversible destruction of the tooth attachment and its surrounding bone.The disease state, if left untreated, can lead to progressive loss of gingival tissue, periodontal ligament and supporting alveolar bone, ultimately resulting in an aesthetically and functionally compromised dentition, including premature tooth loss (**Khan et al 2015).**

The pathogenesis of periodontal disease involves a complex interaction between the host's immune response to microbial colonization of the periodontal attachment, Stress, smoking habits, diabetes mellitus, and systemic diseases are modifying factors that are responsible for the progression of the disease**(Knight et al ,2016).**

The ultimate goal of periodontal therapy is to prevent further attachment loss and predictably restore the periodontal supporting structures that were lost because of disease or trauma in a way that the architecture and function of the lost structures can be reestablished [**Kothiwale ,2014].**

Conventional nonsurgical therapy and periodontal flap procedures successfully halt the progression of periodontal disease but result in soft tissue recession that leads to poor esthetics in the anterior dentition. Moreover, conventional periodontal therapy often results in residual pockets usually inaccessible to adequate cleaning, which negatively affect the long-term prognosis of the treated tooth. These compromised outcomes can be avoided or minimized by periodontal regenerative procedures that restore the lost periodontal structures.

[**Kinane et al , 2017].**Successful periodontal regeneration relies on the re-formation of an epithelial seal, deposition of new acellular extrinsic fiber cementum and insertion of functionally oriented connective tissue fibers into the root surface, and restoration of alveolar bone height.**Caton JG** concept that the cells that repopulate the exposed root surface after periodontal surgery define the nature of the attachment that will form was extensively investigated.therefor the major factor believed to prevent periodontal regeneration after conventional therapeutic approaches is the migration of epithelial cells into the defect area at a faster rate than that of mesenchymal which leads to the formation of a long junctional epithelium and the prevention of the formation of a new attachment apparatus over the previously diseased root surface. gingival connective tissue cells can also populate the space adjacent to the denuded root surface after conventional periodontal treatment.Based on this speculation, the goal of regenerative procedures is to prevent apical migration of gingival epithelial and connective tissue cells and to provide maintenance of a wound space into which a selective population of cells is allowed to migrate, favoring the formation of a new periodontal attachment**.[Kothiwale ,2014].**Current treatment regenerative approaches include number of different procedures have been described to promote true and predictable regeneration of the periodontium since the 1980s. To describe the latest trends, principles of these different treatment approaches includeThe use of graft materials to compensate for the bone loss incurred as a result of periodontal disease,**(Aichelmann-Reidy et al ,1998),**Theuseof barrier membranes for guided tissue regeneration,**(Gottlow et al ,1984)** and The use of bioactive molecules[**Bosshardt ,2008]**

1.2Aim of the study

Define the tissue regeneration and explain its modalities and correlate these modalities with the treatment of periodontal diseases [Infra-bony defects and furcation defects].

1.3Periodontal therapies

1.3.1Non-surgical Periodontal Therapy

Phase I therapy or cause-related therapy is the first in the chronologic sequence of procedures that constitute periodontal treatment.

The major goal of phase I therapy is to control the factors responsible for periodontal inflammation; this involves educating the patient in the removal of bacterial plaque or bioilm. Phase I therapy also includes scaling, root planing, and other therapies such as caries control, replacement of defective restorations, occlusal therapy, orthodontic tooth movement, and cessation of confounding habits such as tobacco use. Comprehensive reevaluation after phase I therapy is essential to determine treatment options and establish a prognosis. Many patients can attain periodontal disease control with phase I therapy alone and do not require further surgical intervention. For patients who require surgical intervention, phase I therapy is an advantageous element of treatment in that it permits tissue healing, thus improving the surgical management and healing response of the tissues **[Newman et al 2019].**

Heitz-Mayield and Lang [2000]demonstrated that surgical treatment in deep pockets, those >6 mm, gained 0.6 mm more probing depth reduction and 0.2 mm more clinical attachment gain than did deep pockets treated with scaling and root planing alone. This study also confirmed that in pockets of 4 to 6 mm probing depth, scaling and root planing resulted in 0.4 mm more attachment gain than surgical procedures, and shallow pockets of 1 to 3 mm had 0.5 mm less attachment loss compared with surgical results. **5-mm standard** has been commonly used as a guideline for identifying candidates for surgical referral based on the understanding that the typical root length is about 13 mm and the crest of the alveolar bone is at a level approximately 2 mm apical to the bottom of the pocket .When there is 5 mm of clinical attachment loss, the crest of bone is about 7 mm apical to the cementoenamel junction, and therefore only about half of the bony support for the tooth remains as shown in [**fig 1.1**]. Periodontal surgery can help improve support for teeth in these cases through pocket reduction, bone augmentation, and regeneration procedures.When there is 5 mm of clinical attachment loss, the crest of bone is about 7 mm apical to the cementoenamel junction, and therefore only about half of the bony support for the tooth remains. Periodontal surgery can help improve support for teeth in these cases through pocket reduction, bone augmentation, and regeneration procedures[**Newman et al ,2019].**

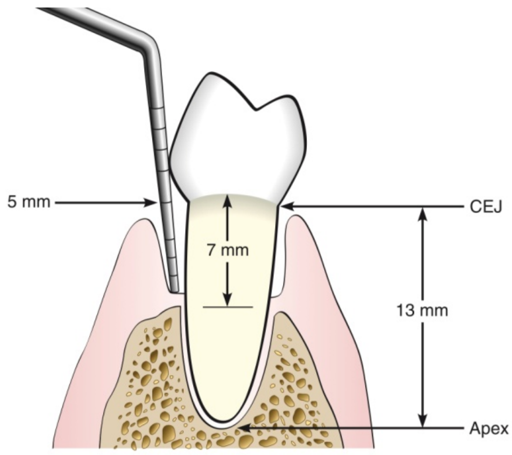

Fig. 1.1 The 5-mm standard for referral to a periodontist is based on root length, probing depth, and clinical attachment loss. The standard serves as a reasonable guideline to analyse the case for referral for specialist care.

1.3.2 Surgical Periodontal Therapy

Therapy for periodontal disease, which encompasses many techniques and procedures, depends on the disease status and objective of the outcome. Early problems can be corrected with successful phase I therapy, consisting of bioilm removal by the patient on a daily basis, scaling, and root planing when necessary.Many moderate to advanced cases cannot be resolved without surgically gaining access to the root surface for root planing and reducing or eliminating pocket depth to allow the patient to remove bioilm. The surgical phase of therapy is also referred to as phase II therapy.**[Newman et al 2019]**

The surgical phase of periodontal therapy has the following objectives:

1. To improve the prognosis for teeth and their replacements

2. To improve aesthetics Surgical techniques are used for pocket therapy and for correction of related morphologic problems (i.e., mucogingival defects).

In many cases, therapies are combined to provide one surgical intervention that fulills both objectives.Surgical techniques

1.Increase access to the root surface, allowing the clinician to remove all irritants;

2.Reduce or eliminate pocket depth, making it possible for the patient to maintain the root surfaces free of bioilm

3.Reshape soft and hard tissues to attain a harmonious topography.

Pocket Reduction Surgery is divided into

• Resective (e.g., gingivectomy, apically displaced lap, undisplaced flap with or without osseous resection)

• Regenerative (e.g., flaps with grafts, membranes,biomaterials).

1.4 Reconstructive techniques

Reconstructive techniques can be subdivided into three major therapeutic approaches:

1.Nonbone graftassociated.**2.**Graft-associated.

3.biological mediator–associated new attachment and regeneration.

In clinical practice, it is common for clinicians to combine these various approaches.

1.4.1Non–Graft-Associated Reconstructive Procedures

Of these is guided tissue regeneration (GTR) that is the main procedure used in clinical practiceThis technique, termed guided tissue regeneration, has recently become a widely accepted clinical procedure, and is currently considered the 'gold standard' upon which to base and compare regenerative therapies.

Based on the hypothesis of [Melcher in 1976]that the first cells to populate a wound will dictate the nature and quality of tissue that forms there.

[Nyman et al 1982]first demonstrated that by guiding the colonization of the periodontal wound healing site by progenitor cells from the periodontal ligament and alveolar bone, and eliminating cells of gingival epithelial and fibroblastic lineages from this site, it is feasible to achieve periodontal regeneration in experimental animals and humans.

Guided tissue regeneration involves utilization of barrier membranes to prevent unwanted epithelium and gingival connective tissue from entering the healing site while recruiting cells from the periodontium to re-populate the defect area.

Besides favoring selective repopulation of the wound area, physical barriers are also thought to provide protection of the blood clot during the early phases of healing and to ensure space maintenance for ingrowth of a new periodontal apparatus**[Han et al,2014]**

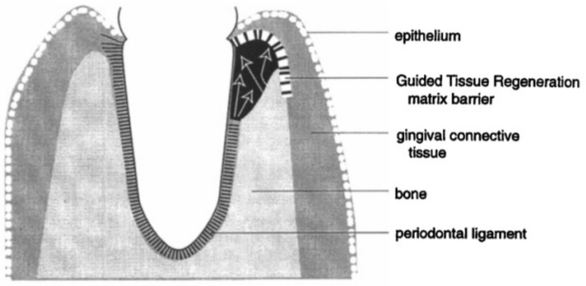

Figure 1.2.Guided tissue regeneration barrier under periodontal flap [epithelium and gingival connective tissue].

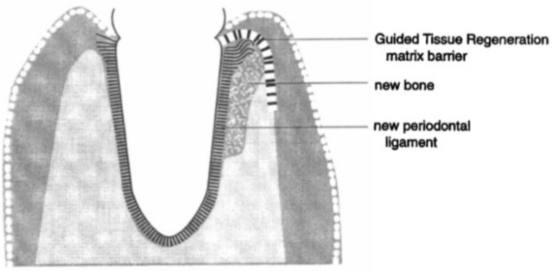

Figure 1.3. Guided tissue regeneration of new periodontal ligament and new bone.

1.5 Barrier membranes for GTR applications

The strategy to isolate the periodontal defect with a mat-like material (resorbable or non-resorbable) that will function as a physical barrier to avoid gingival cell invasion led to the development of GTR/GBR membranes . This GTR membrane need to exhibit**:**

(1) biocompatibility to allow integration with the host tissues without eliciting inflammatory responses,

(2) proper degradation profile to match those of new tissue formation,

(3) adequate mechanical and physical properties to allow its placement in vivo,

(4) sufficient sustained strength to avoid the membrane collapse and perform their barrier function **[Bajpai & Rajasekar,2022**].

1.5.1Nonresorbable Membranes;:

Nonresorbable membranes, made of methyl-cellulose acetate (Millipore, Bedford, MA, USA), were successfully used in the first GTR case.However, these membranes were quite fragile and often tended to tear, which limited their clinical use. Methyl-cellulose acetate barriers were later replaced by nonresorbable ePTFE membranes (GORE-TEX) specifically designed for periodontal regeneration. Most of the current understanding regarding GTR derives from early studies using ePTFE membranes.ePTFE is a synthetic biocompatible polymer consisting of a long carbon backbone to which fluorine atoms are bonded.This membrane is composed of an inner cell occlusive area and an outer cell adherent region.Because of this particular configuration, ePTFE membranes can selectively exclude migration of epithelial and gingival connective tissue cells and integrate with the bone and connective tissue margin of the periodontal defect. This material not only possesses adequate stiffness to allow creation and maintenance of a secluded space into which the new attachment will form but also is supple enough to allow adequate adaptation over the defect **[Sharma et al,2012].**

Titanium-reinforced

Titanium-reinforced configurations are specially indicated when the defect anatomy is not supportive, such as in 1-wall defects.**[Sharma et al,2012]** Studies have revealed that titanium reinforcement of high-density PTFE membranes lead to superior regenerative capacity when compared to traditional expanded PTFE membranes mainly due to the additional mechanical support provided by the titanium frame against the compressive forces exerted by the overlying soft tissue**[S Ramakrishna et al 2001].**

In the study of Cortellini et al. 1995the authors reported that the use of ePTFE membrane reinforced with titanium lead to statistically significant CAL gain, compared to e-PTFE alone. The authors` explanation is based on the fact that membrane with titanium reinforcement could be positioned more coronally compared to e-PTFE alone, increasing the space obtained and promoting better clinical results.

Disadvantages of Nonresorbable Membranes

1.Although excellent clinical results have been shown with the use of ePTFE membranes, their use is associated with high frequency of early spontaneous exposure to the oral environment, which compromises their effectiveness.

2.The necessity of performing an additional surgery for their removal, which implicates not only additional pain and discomfort but also an economic burdenMoreover, these membranes need to be removed after 6 to 8 weeks in a second surgical procedure **[Sanz-Sánchez et al,2022].**

Resorption

As there is no enzyme in the body capable to degrade the carbon-hydrogen bond, the material cannot be degraded by the organism **[Warrer et al 1992].**

1.5.2Bioabsorbable Membranes

Bioabsorbable membranes have been developed primarily to avoid a second surgery for membrane removal. Various bioabsorbable materials, including polyglycoside synthetic polymers (ie, polymers of polylactic acid, polyglycolic acid, polylactate/polygalactate), collagen, and calcium sulfate have been frequently used in membrane barriers.Similar to ePTFE membranes, resorbable membranes are biocompatible and exert their function by excluding undesirable cells from migrating into periodontal defects and providing a space for ingrowth of periodontal attachment.The clinical efficacy of bioabsorbable membranes depends on their ability to retain their structural physical integrity during the first 6 to 8 weeks of healing and to be gradually absorbed thereafter.

Based on this concept, chemicals and structural modifications (ie, polymerization, cross-linking) were incorporated into bioabsorbable membranes to extend their absorption time and increase the clinical effectiveness of these materials**.**However, the prolonged collagen resorption rate does not always result in greater periodontal regeneration. It is possible that membranes are only required to maintain their physical integrity for 6 weeks and prolonged retention after that is detrimental to the healing process**[Villar et al,2010].**

1.5.2.1 Collagen barrier membranes

made primarily from bovine and porcine type I collagen, were successfully used in the treatment of periodontal defects. Collagen membranes are particularly suitable for GTR applications [**Villar et al,2010].**

Function

Its chemotactic,stimulates proliferation of fibroblasts,provides hemostasis, serves as a fibrillar scaffold for vascular and tissue ingrowth,can be easilyshaped,its readily adaptable and acts as a barrier for migrating epithelial cells [**Villar et al,2010].**

Resorption

These membranes are resorbed by the enzymatic activity of macrophages and neutrophils. matrix that provides the basis for tissue structure and guides cellular functions [**Villar et al,2010].**

Collagen-based membranes

1.Shown very poor performance in vivo as the membrane starts to degrade

2.The risks of disease transmission due to the use of human- or animal-derived collagen may pose regulatory or other limitations

Numerous complications are associated with collagen membranes that there are Limitations of collagen membranes include poor mechanical properties and therefore susceptibility to collapse and loss of space-maintaining ability. A major obstacle that resorbable membranes face is the unpredictable resorption time and degree of degradation. The resorption of collagen membranes is dependent upon the source of material (bovine, porcine, human) and the breakdown rate of collagen into oligopeptides and amino acid molecules **[Marco et al,2012].**

1.5.2.2Degradable polymers

constitute a second major group of bioabsorbable barrier membranes. These membranes are formed by copolymerization of polylactic acid, polyglycolic acid, and polylactate/polygalactate. These synthetic membranes remainintact for 20 weeks or more, depending on their polymeric composition **[Grizzi et al 1995].**

Resorption

Afterward they are degraded by hydrolysis of ester bonds and eliminated through metabolic pathways as carbon dioxide and water their hydrolysis is accompanied by a local inflammatory response. The inflammatory response is not considered harmful, but it remains to be established as to what extent it may affect the regeneration of periodontal tissues **[Zhao.S et al 2000].**

A question still needed to be answered is what the ideal degradation time would be for a resorbable membrane[Bottino et al. 2012]suggest that regardless of the resorbable or nonresorbable nature of the membranes, these devices must not degrade and must function for at least 4–6 weeks to allow successful regeneration of the periodontium. As a resorbable membrane does not need to be removed, it may be stated that the longer it maintains its space maintenance ability the better. **On the other side, Wikesjo's work** showed that the game is mostly played in the first few weeks. Already in the first 24 h, a stable clot is created that will be replaced by granulation tissue in the first few days. A bone matrix completely replaces the granulation tissue in 2–4 weeks. The bone matrix will mature into woven bone first and then lamellar bone. With this knowledge in mind, we can safely state that after a few weeks the role of the membrane may be limited, moreover the persistence of a membrane may reduce the vascularity from the flap side, reducing the speed of the maturation phase, as seen in some experimental studies **[Simion et al 2009].**

Comparison between resorbable and nonresorbable

The clinical indication of nonresorbable and bioabsorbable membranes necessitates consideration of the anatomy of the periodontal defect. Therefore, nonresorbable reinforced membranes and bioabsorbable membranes supported by filler materials are used for the treatment of nonsupportive defects, such as in wide 1- or 2-walled periodontal defects. On the other hand, narrower 2-walled defects can be treated with bioabsorbable membranes[**villar et al 2010].**

1.6 (2).Graft Materials in reconstructive periodontal surgery

Numerous bone grafting materials are available for the clinician today and have been used to achieve periodontal regeneration or alveolar ridge reconstructions. Hard tissue replacement materials for periodontal regeneration are categorized into one of four categories: Autogenous bone; allogeneic bone substitutes, such (FDBA) and (DFDBA); xenogeneic; and alloplastic**[Ausenda et al ,2019].**

1.6.1Functions of graft material

Clinically,these materials are used for supporting the soft tissues from collapsing into the defect,for their ability to stabilize the clot andfacilitate bone formation **[Ausenda et al ,2019].**

1.6.2 Autogenous bone

is harvested from a donor site in the same individual and transplanted to another site. Autogenous bone has been considered the gold standard because it acts as scaffold, and it has osteoconductive, osteoinductive, and osteogenic properties

,It has no potential complications of histocompatibility and its use has been studied to fill intrabony defects and to regenerate bone in edentulous areas **[Ausenda et al ,2019].**

Source

In the oral cavity it is usually harvested from surrounding alveolar bone with scrapers from the tuberosity, from the ramus, or from the retromolar region or from the symphysis region in the mandible. As the bone needed for periodontal regeneration is limited, extra oral sites are not usually considered. Its use is not very popular nowadays because its biological advantages are to be weighted with the biological cost of harvesting bone from a second donor site,leading to higher morbidity, increased surgical time, and risk of graft contamination. Moreover, its replacement rate may be unpredictable**[Tsu, Y.T.and Wang, H.L 2013],[Sheikh et al 2017];**

1.6.3 Allogeneic bone

substitutes are materials that are derived from a human donor (same species) with a different genetic heritage.They lead to less patient morbidity, since they overcome the disadvantage of the need for a second surgical site from which to harvest the graft, and if needed a large quantity can be used.

*DFDBA has also shown limited osteoinductive capabilities..

*FFBA provides the highest osteoconductive and osteoinductive potential among all allograft materials, though it is no longer used due to the risk of disease transmission.
*Allogeneic bone freezing and drying processes are performed in order to reduce antigenicity.
*The freeze-drying process distorts the 3D presentation of the human leukocyte antigens on the surface of graft particles that affects the immune recognition.
*FDBA is more slowly resorbed than DFDBA**(** Demineralized freeze-dried bone allografts have a potential for osteoinduction with some expression of bone morphogenetic proteins (BMP). Some authors state that DFDBA has osteoinductive properties ,others say that its osteoinductive potential is lowIts complete replacement by new autologous bone is slow **[Ausenda et al ,2019].**

1.6.4Xenogeneic bone

substitutes are grafting materials that derive from a different species than that of the receiving organism. Xenogeneic scaffolds available for periodontal regeneration can be of bovine, porcine, or equine origin **[Ausenda et al ,2019].**

Advantageous

Like allografts, they spare the patient the need for a second surgical site, leading to less morbidity.These biomaterials undergo a deproteinization and demineralization process through thermal and chemical treatment with the utilization of sodium hydroxide.Xenografts can usually be found as cortical or cancellous particles with different granule sizes or as cancellous blocks. They have good osteoconductive properties and a slow resorption rate. Long-term histological analyses found evidence of xenogeneic particles from as late as three years after implantationto as late as 16 years **[Ausenda et al ,2019].**

Alloplastic bone

substitutes are grafting materials for periodontal regeneration. They are synthetic products that provide no risk of infections and are easily available, biocompatible, and have osteoconductive properties **[Ausenda et al ,2019].**

<u>They can be made of several different materials</u>

1.Bioceramics have a similar structure to the inorganic bone component.

2.Absorbable/non-resorbable hydroxyapatite is biologically inert and biocompatible.It acts as a filler, does not contribute to bone formation, and has a slow resorption rate

3.Beta-tricalcium phosphate (β -TCP) once placed is completely resorbed in six to nine months and substituted by new bone

4.Bioglass materials are made of a glassy ceramic, zinc oxide, and calcium oxide, they also have osteoconductive properties but are hardly resorbed.

5.Biocoral allografts are mostly made of calcium carbonate in the form of argonite or pure calcium carbonate, strontium, fluoride, magnesium, sodium, potassium. Biocoral is an osteoconductor and allows bone growth both by apposition and by substitution.

6.Polylactic acid polymers are also available for use in periodontal regeneration. They are biocompatible and biodegradable.

The bioproducts are potentially toxic but are released in such small amounts that theyhave no dangerous effects.

Given the large array of grafting biomaterials available, the clinician may find him/herself lost in the selection of the best option. With the exception of DFDBA, which may retain some osteoinductive properties, most grafting materials exert their function through their osteoconductive properties.

In contemporary periodontology, usually autogenous bone is not the grafting material of choice for periodontal regeneration since its harvesting often requires a second surgical site and its resorption rate is unpredictable

Allogeneic bone substitutes, FDBA, and DFDBA are considered the gold standard. FDBA is usually more slowly resorbed than DFDBA . These allogeneic materials do not require a second surgical site, they promote regeneration by stabilizing the blot clotand preventing the soft tissue collapse into the defect **[Ausenda et al ,2019].**

1.7 (3) Tissue Engineering with Biologic Mediators for reconstructive surgery in the treatment of periodontal diseases

In wound healing, the natural healing process usually results in tissue scarring or repair. Using tissue engineering, the wound healing process is manipulated so that tissue regeneration occurs.This manipulation usually involves one or more of the three key elements: the signaling molecules, scaffold or supporting matrices, and cells **[fig 1.4]** .Membranes and scaffolding graft materials have been used to take advantage of their osteoconductive properties. Several biologic agents have been studied to stimulate osteoinduction. The concepts behind the use of growth factors and differentiation factors in oral tissue regeneration are based on the seminal research by Marshall R. Urist in the late 1960s.but it was not until the late 1980s to early 1990s that the use of growth factors started to be tested directly for periodontal regeneration **[Newman et al ,2019].**

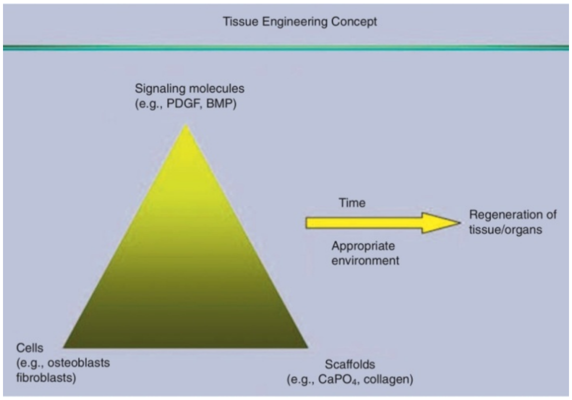

Figure [1.4]Tissue engineering is the manipulation of one or more of the three elements: signalling molecules, scaffolds, or cells. BMP, Bonemorphogenetic protein; CaPO4 , calcium phosphate; PDGF, platelet-derived growth factor.

1.7.1 Amelogenins

One of the most widely used biologics is enamel matrix derivative (EMD). It was first introduced to the market in the late 1990s, and it is an extract porcine fetal tooth EMD. amelogenin used to stimulate periodontal regeneration to form new bone, PDL, and cementum. EMD is thought to mimic the development of the tooth-supporting apparatus during tooth formation . Clinical and histologic studies have demonstrated that EMD will regenerate the periodontal attachment apparatus on teeth previously affected by periodontal disease in advanced periodontal defects . Some clinical investigations have not found great clinical improvements with the use of EMD , however, there is evidence of regeneration with the use of EMD both in furcation and in intrabony defects . In a systematic review, **Esposito (2009)**found that EMD significantly improved CAL by 1.1 mm and reduced PPD by 0.9 mm**[Ausenda et al ,2019].**

1.7.2 Platelet-derived growth factor:

Recombinant human platelet-derived growth factor (rh-PDGF) can be used to treat intrabony defects and gingival recession deformities. It is manufactured using recombinant DNA technology, and it is mitogenic and chemotactic for osteoblasts, cementoblasts, and PDL cells. Its clinical use in conjunction with a carrier (β -TCP or DFDBA) has been investigated with clinically positive results [**Ausenda et al ,2019].**

1.7.3Bone morphogenic proteins (BMPs)

The most commonly studied BMPs in the periodontal field are BMP-2 and BMP-7. They have osteoinductive potential as they have the ability to stimulate PDL cells differentiation into osteoblasts and increase expression of mineralized tissue markers [**Ripamonti, U.and Renton, L 2006]**.RhBMP-2, along with a collagen sponge as carrier, has been successfully used for ridge preservation procedures following tooth extraction in both molar areas **[Howell et al 1997] [Cochran et al 2000]**as well as in larger defects **[Fiorellini et al 2005].** Its utilization in intrabony and furcation defects has been successfulhowever, ankylosis and root resorption has also been described **[Wikesjö et al 1999]** When rhBMP-2 is utilized in combination with autologous bone it appears to further enhance cell activity.BMP-7 has been studied delivered with a collagen sponge to stimulate bone growth in sinus augmentation procedures. In a study comparing its use against deproteinizedbone alone, there was a significant higher amount of newly formed bone in the control group **[Corinaldesi et al 2013].**

It is interesting to notice that not all BMPs function in the same way**[Wikesjo et al 2004]** compared rhBMP-2 and rhBMP-12 in a canine model, rhBMP-2 resulted in more robust bone formation, but periodontal fibers run parallel to the root surface, while rhBMP-12 resulted in perpendicular finer orientation

1.7.4 FIBROBLAST GROWTH FACTOR

Fibroblast growth factor-2 (FGF-2) is a heparin-biding cytokine which is able to enhance the angiogenic and osteogenic activity of multiple cellular populations. **[Nagayasu-Tanaka et al 2015] [Shujaa Addin et al 2017]** In addition, FGF-2 can stimulate the proliferation and migration of mesenchymal cells within the PDL**[Murakami2011].**

1.7.5 PLATELET CONCENTRATES

A patient's own blood has been centrifugated as documented in multiple fields of medicine to concentrate platelets in an attempt to increase the density of growth factors and enhance wound healing[**Larsson et al 2016**].Platelet concentrateshave been considered wound healing promoters for infrabony defects and sinus floor elevation **[Del Fabbro et al 2018],[Comert Kilic et al 2017]**as well as used as a scaffold matrix in root coverageprocedures.

1.7.6 Cell Therapy

Cell therapy has been used in periodontal surgery (Osteocel Plus, NuVasive, San Diego, CA). Stem cells have the potential to improve current bone regeneration. These cells can expedite cell recruitment, be target cells for growth factor delivery, and promote earlyextracellular matrix formation. All of these cellular activities increase the bioactivity of the graft.MSC cellular allograft bone represents a unique, nonimmune material rich in MSCs, osteoblasts, and osteocytes. This osteoinductive cellular graft represents an attractive alternative to autograft bone by eliminating a secondary surgical harvest site and morbidity risk

this cellular allograft has been used successfully in regenerative treatment of periodontal defects in both a single-rooted tooth and a multirooted tooth **[Newman et al ,2019].**

Chapter 2

Treatment of Infra bony defects by Reconstructive Surgical Techniques:

2.1 The periodontal pocket :- .

It's an inflammatory changes and apical migration of junctional epithelium; it is also defined as a pathological deepening of gingival sulcus, which occurs by coronal movement of gingival margin, apical displacement of gingival attachment, or both**[Newman et al ,2019].**

Classification

Deepening of the gingival sulcus may occur as a result of coronal movement of the gingival margin, apical displacement of the gingival attachment, or a combination of the two processes. Pockets can be classified as follows:

1.According to the involved tooth surface:

a) Simple pocket: involve one surface

b) Compound pocket: involve more than one surface

c) Complex or spiral pocket: originating on one surface and twisting around the tooth toinvolve one or more additional surface (but it opens into the oral cavity on the surface ofits origin). These types of pockets are most common in furcation areas.

2. **According to its location as shown in fig [2.1]**

1- Gingival pocket (also called False or "pseudo-pocket") is formed by gingival enlargement without destruction of the underlying periodontal tissues. The sulcus is deepened because of the increased bulk of the gingiva. As

2- Periodontal pocket produces destruction of the supporting periodontal tissues, leading to the loosening and exfoliation of the teeth. Based on the location of the base of the pocket in relation to the underlying bone, periodontal pockets can be classified into the following types:

A- Suprabony (supra-crestal or supra-alveolar) occurs when the bottom of the pocket is coronal to the underlying alveolar bone. The pattern of destruction of the underlying bone is horizontal.

B- Intrabony (infrabony, subcrestal, or intra-alveolar) occurs when the bottom of the pocket is apical to the level of the adjacent alveolar bone. The lateral pocket wall lies between the tooth surface and the alveolar bone. The pattern of bone destruction is vertical (angular) **[Newman et al ,2019].**

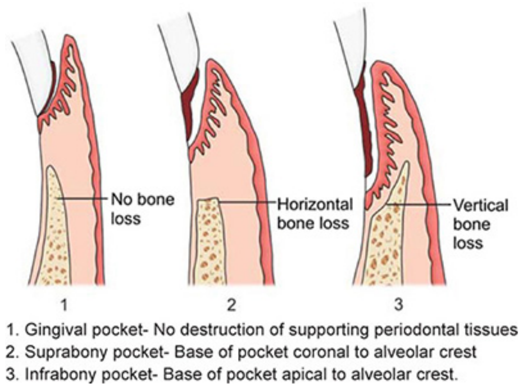

Figure [2.1]the classification of pockets-accordingly to locations.

Classification of Infrabony pocket according to:

The depth and width of the defect:

1 . Narrow deep pocket

2. Wide deep pocket

3. Narrow shallow pocket

4. Deep shallow pocket.

The number of the remaining osseous walls:

1.Three osseous wall infrabonypocket

2.Tow osseous wall infrabony pocket

3.One osseous wall infrabony pocket

4- Combined osseous defect

These defects are classified on bases of No. of osseous walls present as shown in **fig [2.2]**

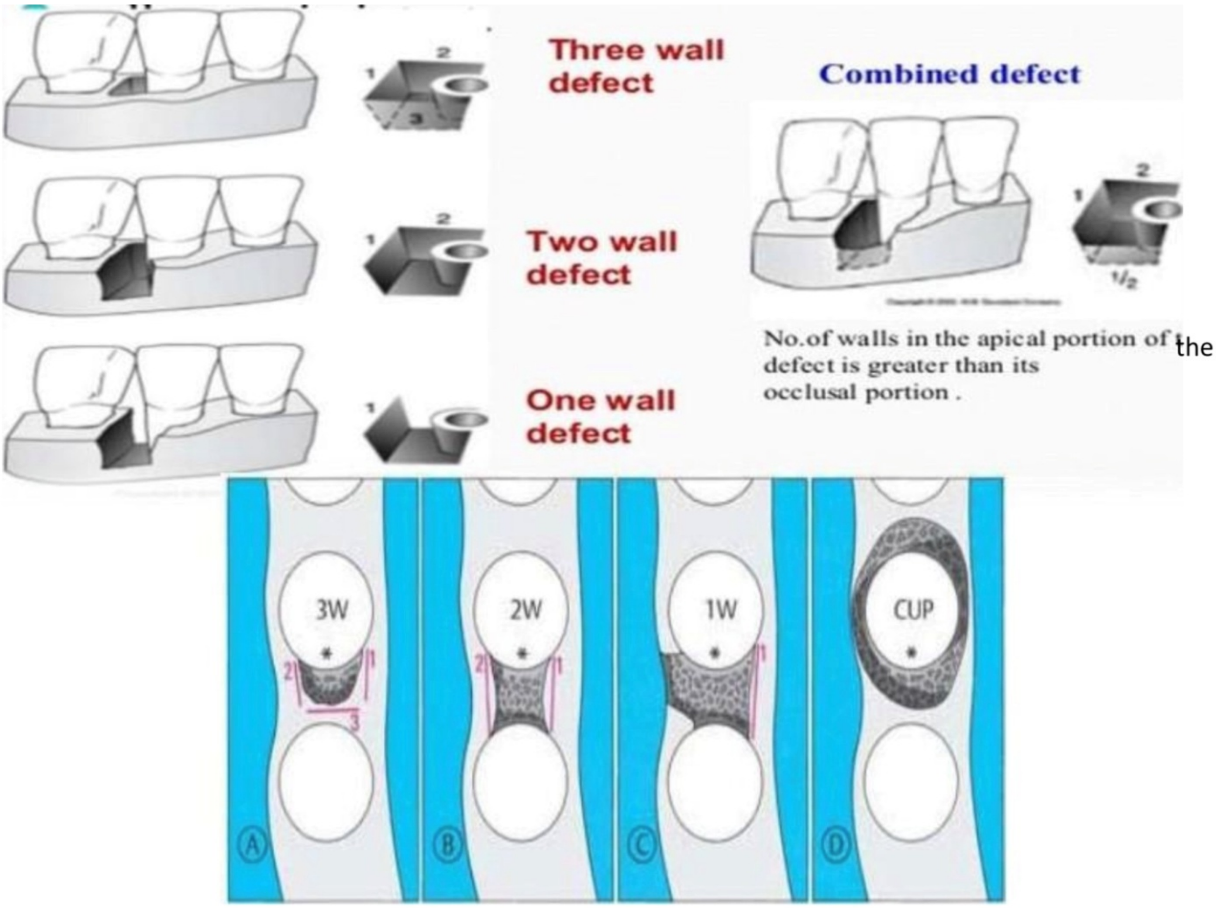

Figure [2.2] The classification of infra bony pockets.

The Treatment of Infra bony defects by Reconstructive Surgical Techniques can be done by

2.2 (1) By using non absorbable membrane

A Case Report Of 30-year Stability After Regeneration of a Deep Intrabony Defect. [Giovanpaolo Pini Prato,2016]

***Aims*: report clinical improvements and 30 years stability of clinical outcomes of an intrabony defect treated with non-resorbable barriers and mucogingival surgery.**

Methods

A 18 years-old male presenting with a very severe intrabony defect at the upper right central incisor was treated with periodontal regeneration with non-resorbable barriers and a fibrin-fibronectin glue. The barriers were removed after 3 months. At 6 months a free gingival graft (FGG) was positioned to improve mucogingival conditions. The patient was enrolled into a 6-month supportive periodontal care program (SPC) for 30 years.

***Results*:** Clinical attachment level (CAL) of 16mm was associated with a 12mm osseous defect and a pocket (PD) 14mm deep. At 1-year, a CAL of 5mm was associated with a PD of 2mm. The 5mm gingival recession measured at 6 months and treated with FGG was reduced to 3mm. Measurements taken at 10, 20 and 30 years showed a consistent creeping of the gingival margin. At 30-year examination, CAL gain was 12 mm associated with a 2mm PD and a minimal gingival recession.

Conclusions: this case demonstrates that it is possible to treat a very severe infrabony pocket applying regeneration and mucogingival surgery and tomaintain the clinical outcomes for 30 years.

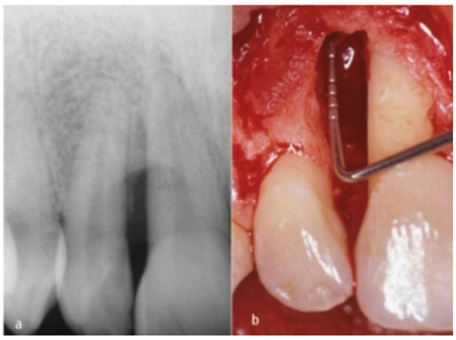

Figure 2.3 : a) radiographic appearance of the involved area, showing radiolucency between central and lateral maxillary right incisors. b) A full thickness flap was elevated. There was a combination of 1, 2, 3 wall osseous defect about 12 mm deep on the distal aspect of the central incisor.

Figure 2.4: a) The re-entry procedure was performed three months after surgery. The osseous defect was filled up to 7 mm from the cemento enamel junction. b) Six months after the GTR procedure, probing depth was 2mm and the appearance of the keratinized tissue was poor.

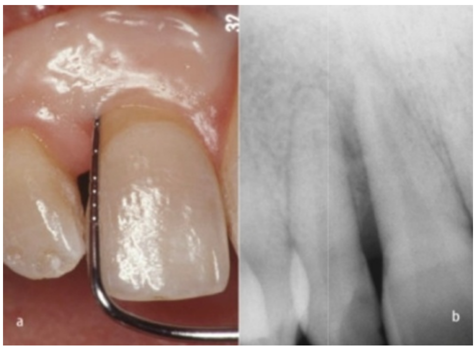

Figure 2.5: a) After 1year the appearance of the area improved by a free gingival graft; the pocket depth was 2 mm associated with 3mm recession. b) the radiograph shows appreciable bone regrowth.

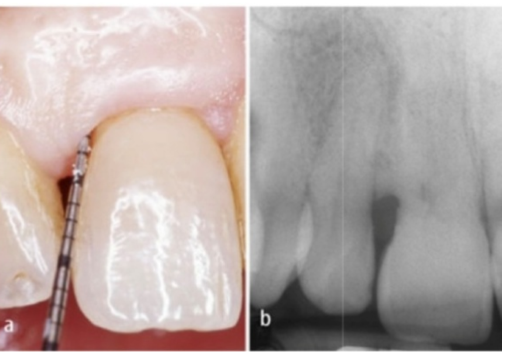

Figure 2.6: 20 year follow-up. a) The clinical view shows 3 mm of residual probing depth. Due to "creeping attachment" of the marginal tissue over time, recession was reduced to 1mm at central and lateral incisors. b) the 20 years radiograph shows the complete bone fill of the defect.The distance between bone-crest / CEJ is 2.5 mm.

<u>Figure 2.8</u> 30 year follow-up. a) The clinical view shows 3.0mm of probing depth. Due to the continuous "creeping attachment " complete root coverage occurred on both incisors. b)The radiograph confirms the stability of complete bone fill of the defect.The crestal bone is dense and close to the CEJ:distance between bone-crest / CEJ is 2.0 mm.

2.3 [2]*<u>Bioabsorbable Membranes</u>*

Collagen membranes for GTR have been tested by several animal and clinical trials. In a recent systematic review, 21 clinical trials that investigated the used of collagen membranes for GTR, with and without addition of bone substitutes, were included. The results demonstrate CAL gain of 1.58 mm (95% CI, 1.27 to 1.88), without difference between studies that used or not bone substitutes[**Stoecklin-Wasmer et al 2013].**

Hence, in cases in which membrane mechanical stability can not be achieved during surgery due to defect configuration, a bone substitute filling is indicated to ensure space maintenance.Data from most randomized controlled clinical trialsindicate that treatment of intrabony defects with GTR results in significantly greater probing depth reductions and clinical attachment gains compared with open flap debridement alone. The observed differences in favor of GTR are supported by the results of a meta-analysis that shows that compared with open flap debridement, GTR results in an additional gain of1.22 mm in clinical attachment level and further reduction of 1.21 mm in probing depth.Clinical improvements associated with GTR are independent of the type of barrier membrane used (ie, nonresorbable, resorbable) can be maintained over time **[Needleman et al ,2019].**

2.4 [3] BONE GRAFTS

Filling intrabony defect with bone graft provides a scaffold for cell proliferation and also gives proper stability for membrane, avoiding its collapse, which would reduce the intrabony space to be regenerated. There are several experimental researches demonstrating the negative effect of membrane collapseGenerally, the space obtained with membrane placement influences directly on the amount of new bone formation.The studies comparing GTR associated with bone grafts versus GTR alone demonstrate similar CAL gain but greater amount of hard tissue gain at reentry surgery.[**Yuan et al 2021]** Three controlled clinical trials **[Chen et al 1995],[Mellado et al 1995] [Gouldin et al 1996]**evaluated the use of DFDBA associated with barrier membrane and compared to membrane alone (one study used collagen membrane and two used e-PTFE to membrane) in deep intrabony defects. The results demonstrated that both treatments improved clinical parameters without difference between them after 6 months of follow-up.**[Silva et al ,2017]** Therefore, there are evidences supporting the idea that GTR with allogeneic-sourced bone or synthetic bone do not improve the host regenerative potential and that healing process in these cases are still unknown**[Susin and Wikesjö UM 2013].**

2.5 [4] ENAMEL MATRIX DERIVATIVE

Based on the limitations of bone graft materials, an enamel matrix derivative (EMD) was developed by Straumann ® Company,commercially available as Emdogain®.The idea is to induce periodontal regeneration with a simpler surgical procedure with less postoperative complications.The clinical performance of EMD was well elucidated in a systematic review performed by**[Esposito et al. 2009]**In the treatment of intrabony defects with EMD, compared to open flap debridement, it was observed, in average, 1.1 mm of CAL gain and 0.9 mm of PPD reduction.The systematic review also compared

EMD with barrier membrane and no difference was found between groups in terms of CAL gain, PPD reduction and tooth loss. An interesting result was the significant difference on postoperative complication rate. Only four patients from the EMD group had complications. Whereas, 59 patients treated with barrier membrane had complications, due to high rates of membrane exposures and abscesses. However, two cases from the same study showed an association between EMD and inflammatory external root resorption.Another advantage of EMD use is its presentation form.The gel can be applied directly into bone defect avoiding vertical releasing incisions and extension of periosteal flap. Thus, a minimally invasive procedure can be done with shorter mesio-distal incision and minimal flap elevation, which can be associated with a papilla preservation technique. Minimally invasive procedure was introduced by Cortellini & Tonetti 2007 , particularly for EMD and growth factors use in periodontal regenerations. This surgical procedure improves esthetic outcomes and also decreases postoperative complications, such as pain, swelling and amount of medication taken.The use of EMD is associated with root conditioning after debridement and before application of gel, intending to remove the smear layer. The most common root conditioner is EDTA 24% (commercially called PrefGel®). Although it has been a common clinical practice, there is no evidence that such procedure improves clinical outcomes. There are also other agents like citric acid, tetracycline HCl, phosphoric acid and fibronectin that failed to demonstrate clinical benefits at periodontal regeneration **[Silva et al ,2017].**

2.6 [5]GROWTH FACTORS

Another treatment modality of GTR for intrabony defects is the use of growth factor, such as platelet-derived growth factor (PDGF). The use of growth factors for GTR were first tested in pre-clinical studies conducted during the early 1990s.Clinical effectiveness of PDGF is based on two separated multicenter, randomized, controlled clinical trials These studies compared the use of 0.3 mg/mL of PDGF + beta tricalcium phosphate (β-TCP) to β-TCPalone.

The results of Nevins et al. 2005 demonstrated only 0.2 mm more CAL gain, but 1.7 mm more bone filling comparing the two treatment types

Jayakumar et al. 2011 demonstrated that addition of this growth factor led to 0.9 mm on CAL gain and promoted 0.9 mm more bone filling.

It is notable that there is some evidence that PDGF can modify healing, favoring periodontal regeneration. However, some considerations related to cost, protein stability and safety are some reasons why this protein is still not used routinely.

2.7 [6]Cellular Therapy

In the single-rooted case, a significant reduction in probing was obtained with radiologic evidence of approximately 4 mm of vertical bone ill at 6 months following grafting. In the multirooted case, clinical evidence showed decreased probing depths and radiographic bone improvement at 6 months. A cone beam computed tomography scan taken at 14 months demonstrated three-dimensional bone ill. A similar result was presented in a case report, where this allograft cellular bone matrix was used in the successful treatment of a severe periodontal defect. These case reports indicate a potential resolution of periodontal defects using cellular allograft material [**Koo et al 2012].**

2.8 Surgical techniques

2.8.1Modified Papilla Preservation Technique:

This technique is indicated for anterior region and in cases that patients' esthetic expectations are high. Although it is a sensitive technique, it has been proved that Modified Papilla Preservation Technique (MPPT) is very effective, especially in wide interdental spaces (>2 mm at the most coronal portion of the papilla)It is noteworthy that flap should be thick to prevent necrosis, and interdental papilla must be preserved as much as possible in order to cover the membrane completely. Membrane size must surpass the defect margin between 3-5 mm this technique is shown in **fig(12)[silva et al 2017].**

2.8.2 Simplified Papilla Preservation Flap

narrower sites (<2mm at the most coronal portion of the papilla), the MPPT is difficult to apply, especially in posterior areas and when using.non-supportive membranes this technique is been shown in **fig 2.9 [silva 2017].**

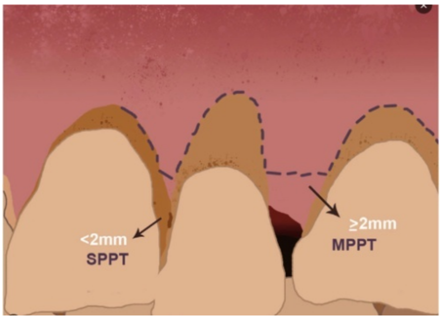

Figure 2.9. SPPT AND MPPT.

2.9 Post-Operative Care

The post-operative care is vital to a successful treatment. The aim is to avoid contamination or infection of the membrane. When membrane exposure associated to infection is identified, systemic antibiotics should be prescribed (amoxicilin 1.5g/day for seven days) and a rinse with 0.12% chlorhexidine gluconate two times per day, for fifteen days is also recommended.

A weekly professional tooth cleaning with supragingival prophylaxis with a rubber cup and chlorhexidine gel should be done until the site is completely healed.When non-bioabsorbable membranes are used, they need to be removed 4–6 weeks after placement. After membrane removal, with a partial-thickness flaps, a rinse with 0.12% chlorhexidine gluconate two times per day, for fifteen days, is recommended. Mechanical oral hygiene and chew in the treated area are avoided for 3–4 weeks. In this period, weekly professional plaque control and prophylaxis are recommended. After a completely site healing, patient can be enrolled in periodontal care program**[silva et al 2017].**

2.10Complications

Membrane exposure is the most common complication, If the non-bioabsorbable membrane is infected, it should be removed,When the exposure is limited, patient should be advised to rinse with 0.12% chlorhexidine gluconate two times per day, for fifteen days and amoxicillin 1.5g/day for seven days should be prescribed. Weekly monitoring, until complete 6 weeks for membraneremoval should be done.The exposed bioabsorbable membranes with no signs of infection can be maintained, but some care must be taken. Patient should be advised to rinse with 0.12% chlorhexidine gluconate two times per day, for fifteen days. Weekly monitoring, until complete healing, should also be done **[silva et al 2017].**

2.11 Risk FACTORS

2.11.1 [1] smoking

A smoking cessation advice should be offered before periodontal therapy. If the habit persists, patient needs to be informed that smoking habit may reduce expected outcomes, especially during healing period. Clinical results of studies have shown significantly less reduction in probing depth among smokers as compared to nonsmokers. A reduced probing depth has been found in smokers as well as in nonsmokers ranging from 0.7641 to 2.05 mm and from 1.2741 to 2.40 mm, respectively With regard to clinical attachment level (CAL), nonsmokers have been shown to gain between 0.2939 and 1.6 mm compared to smokers who gained between 0.0939 and 1.2 mm**[Madi,2023].**

2.11.2 [2] Morphology of the Defect

Bone gain and increase in CAL of a regenerated intrabony defect is also influenced by defect morphology. Some studies have shown a greater Guided Tissue Regeneration in Intrabony DefectsCAL gain in deep defects, however, insertion gain is smaller in wider defects.**[silva et al ,2017]**

Clinical evidence indicates that after GTR, intrabony defects deeper than 3 mm show greater probing attachment gain and bone fill than shallow defects.

Defect width, which comprises the angle formed between defect wall and tooth long axis, can influence the final outcome

A study with 242 intrabony defects, treated with membranes,demonstrated that defects with less than 25º show better results (average 1.6mm in attachment gain) compared to defects with more than 37º **[Cortellini et al 1999]**However, studies demonstrated that defect with unfavorable angles can obtain higher success rate when the correct regenerative technology is associated in the surgery, like supportive membranes associated with bone replacement graft or EMD

The number of residual bony walls was related to the outcomes of various regenerative approaches**.** Defects with three walls tend to -be more predictable compared to defects with two wall [**silva et al ,2017].**

Chapter 3

Tissue regeneration for FURCATION DEFECTS

Inlammatory periodontal disease, if unabated, ultimately progresses to attachment loss suficient to affect the bifurcation or trifurcation of multirooted teeth. The furcation is an area of complex anatomic morphology that may be dificult or impossible to debride by routine periodontal instrumentation.Routine home care methodsmay not keep the furcation area free of plaque**[Newman et al ,2019].**

3.1 Etiologic Factors

The primary etiologic factor in the development of furcation defects is bacterial plaque and the inlammatory consequences that result from its long-term presence. The extent of attachment loss required to produce a furcation defect is variable and related to local anatomic factors (e.g., root trunk length, root morphology)and local developmental anomalies (e.g., cervical enamel projections [CEPs]).Local factors may affect the rate of plaque deposition or complicate the performance of oral hygiene procedures, thereby contributing to the development of periodontitis and attachment loss. Studies indicate that prevalence and severity of furcation involvement increase with age.Dental caries and pulpal death may also affect a tooth withfurcation involvement or even the area of the furcation. All of these factors should be considered during the diagnosis, treatment planning, and therapy of the patient with furcation defects **[Newman et al ,2019].**

3.2 Local Anatomic Factors that precipitate in the etiology of furcation defects

Root Trunk Length

A key factor in both the development and the treatment of furcation involvement is the root trunk length. The distance from thecementoenamel junction to the entrance of the furcation can vary extensively.Once the furcation is exposed, teeth with short root trunks may be more accessible to maintenance procedures, and the short root trunks may facilitate some surgical procedures. Alternatively, teeth with unusually long root trunks or fused roots may not be appropriate candidates for treatment once the furcation has been affected **[Newman et al ,2019].**

Root Length

Root length is directly related to the quantity of attachment supporting the tooth Teeth with long roots and short to moderate root trunklength are more readily treated because suficient attachment remains to meet functional demands**[Newman et al ,2019].**

Interradicular Dimension

The degree of separation of the roots is also an important factor in treatment planning. Closely approximated or fused roots can preclude adequate instrumentation during scaling, root planing, and surgery. Teeth with widely separated roots present more treatment options and are more readily treated**[Newman et al ,2019].**

Cervical Enamel Projections

Cervical enamel projections (CEPs) are reported to occur on 8.6% to 28.6% of molars. The prevalence is highest for mandibularand maxillary second molars.These projections can affect plaque removal, can complicate scaling and root planing, and may be a local factor in the development of gingivitis and periodontitis. CEPs should be removed to facilitate maintenance.**[Newman et al ,2019]**

3.3 Classification of furcation defects

1-Class I (Initial): denotes horizontal loss of periodontal tissue exceeding 1/3 of the width of the tooth as shown in in **figure (3.1)**

Figure 3.1.Class I.

2.Class II (Partial): denotes horizontal loss of periodontal tissue support exceeding1/3 of the width tooth but not encompassing the total the furcation area As shown in **Figure 3.2**.

Figure.3.2 class II.

3- Class III (Total) : denotes horizontal (through and through) destruction of the periodontal tissue support in the furcation area as shown in **Figure 3.3**

Figure.3.3 Class III

Some times we may have *Class IV* when we have furcation involvement that covered by only gingiva.

3.4 Prognosis

1..Maxillary first premolar often shows fusion of the roots and the furcation area
may be located very much apically and also the roots of the maxillary first premolars

are placed buccally and palatally with furcation opening in a mesiodistal direction. Forthese reasons, furcation involvement in maxillary first premolar has poor prognosis[**Karale. (2012)].**

2..In the case of maxillary molars furcations may open bucally, mesially and distalbecause of the presence of the three roots. Since access from proximal areas isdifficult for plaque control, prognosis of furcation involvement in maxillary molars is not good.**[Walter et al 2010]**.

3.Mandibular molars have two roots, placed mesially and distally and the furcation opens buccolingually. The roots are usually divergent especially in mandibular first molars. As a result prognosis of furcation involvement in mandibular molar (especially the first molar) is considered good.[**Marcaccini et al, 2012].**

3.5 Treatment of furcation defects by guided tissue regeneration and bone graft

the treatment success of multirooted teeth depends on the complete elimination of the plaque retention areas from the bi/tri-furcation area and maintenance of meticulous posterior oral hygiene by the patients. Several techniques have been suggested for the treatment of furcation, including root resection, overall retail odontoplasty, scraping open field, extraction, and GTR in more recent times**[silva et al ,2017].**GTR is used in furcation defects to exclude connective tissue and epithelial tissue from the defect area around the root, which is to be repopulated by the tissue existing previously, i.e., cement and bonetissue, and to allow the reformation of periodontal ligament fibers.

3.6 Bone replacement grafts with guided tissue regeneration in treatment of grade II furcation defects: a systematic review and meta-analysis.[Swami et al 2021]

Aim: The present systematic review appended with meta-analysis aimed to evaluate the efficacy of bone replacement graft (BRG) with guided tissue regeneration (GTR) over BRG or open flap debridement (OFD) alone in the treatment of grade II furcation defects.

Materials and methods An electronic literature search of PubMed, Cochrane Library and Google Scholar databases accompanied with manual searching was done. Randomized controlled trials (RCTs) up to October 2019, comparing BRG+GTR with BRG or OFD in grade II furcation defects, were identified. Clinical attachment level (CAL) gain, changes in gingival marginal level (GML), vertical defect fill (VDF), horizontal defect fill (HDF) and reduction in defect volume were the outcome parameters. Results Of a total of 12, 9 studies compared BRG+GTR vs BRG while 3 compared BRG+GTR vs OFD. Meta-analysis was carried out for CAL gain, VDF, HDF and GML changes. In the BRG+GTR vs BRG comparison group, out of 9 studies, 6 RCTs showed standardized mean difference (SMD) of 0.513 for VDF, 9 RCTs showed SMD of 0.83 for HDF and 2 RCTs showed SMD of 0.651 for CAL gain, whereas only 2 studies in the same group reported reduction in defect volume. Three studies of the BRG+GTR vs OFD group exhibited significant VDF and CAL gain with SMD of 2.002 and 1.161 respectively. However, no significant change was recorded for GML in both groups.

Conclusion The present systematic review indicates supplemental benefits of combination therapy of BRG+GTR over monotherapy in resolving grade II furcation defects.

3.7 Surgical Technique to treat the furcation defect by using GTR

McClain & Schallhorn 2000 in their review describe the technique used for the treatment of bifurcation lesions, with or without the use of bone grafts. According to the authors

1.The techniques used in these cases involve the creation of a sulcular incision in envelope form, in order to ensure maximum gingival retention, while at the same time exposing the defect sufficiently, debriding the defect, planning the root surface, and ensuring thorough cleaning of the region, removing plaques and enamel projections, and making any other alterations.

2.Odontoplasty can then be performed if necessary. Bone graft, when used, is hydrated with an anesthetic, sterile saline, or tetracycline solution, and set aside. The selected membrane is trimmed to the desired size, and set aside. The root surface is treated with citric acid, and is scraped to stimulate bleeding.

3.The bone defect is completely filled with bone graft, the membrane is placed over the graft and the flap is positioned to cover it completely. The wound is closed with suture made from non-resorbable yarn.

4.If using non-resorbable membranes, they must be removed 6–8 weeks after surgery, with minimal flap reflection and with maximum smoothness, and then incision sutured again.[**Prathap et al. 2013]**did not use citric acid. After root planning, the authors applied topical tetracycline chloride, to eliminate degenerated Sharpey's fibers, bacteria, bacterial products, disintegrated cementum, and dentin from the root surfaces. For postoperative care, the authors prescribed antibiotics and analgesics.

Figure 3.4.Surgical treatment for the furcation defect

3.8 Comparative studies of EMD treatment in combination with other methods for the treatment of periodontal furcations [Jaiswal and Deo 2013]

EMD versus GTR

According to Jespen et al that conducted a clinical study that compared the effectiveness of EMD to barrier membranes for treating mandibular buccal class II furcation defects. Forty-five patients with buccal class II furcation defects (probing depth >3 mm horizontally), full-mouth bleeding scores less than 25%, and full-mouth plaque scores were selected at baseline. In any of the following conditions patients were excluded from the study:

(1) If they were involved in any other clinical trials;
(2) had medical complications such as uncontrolled diabetes;
(3) had been treated with antibiotics 3 months before surgery;
(4) had molar restorations with buccal margins spreading out <1 mm from the entrance of the furcation;
(5) had class II lingual furcation defects; or
(6) had nonvital molars with posts or screw-retentive restorations or nonvital molars that had not undergone root canal therapy (RCT).

Of 45 defects treated with EMD, 35 showed reduction, 9 defects had no improvement, and 1 worsened.

Clinical observations also revealed that in the group treated with barrier membrane, 30 defects reduced, 11 did not improve, and 4 worsened.

The number of defects completely reduced were 8 and 3 after treatment with EMD and barrier membrane, respectively. Statistical analysis of data showed significant reduction in the horizontal depth of furcation defects in the EMD-treated group, compared to the group treated with GTR. The occurrence of

pain/swelling after surgery was also lower in the EMD-treated group. Furthermore, it is noteworthy that
antibiotics were prescribed four times less in the EMD-treated group compared to the membrane therapy group.

[EMD + allogenic bone graft + GTR]

In 2013, Jaiswal and Deo conducted a clinical study to assess the use of EMD combined with demineralized freeze-dried bone allograft (BG) and GTR using bio-resorbable membrane for treating class II furcations.

Thirty healthy patients diagnosed with chronic periodontitis having a mandibular class II buccal or lingual furcation were selected. Horizontal probing depth of furcations was not less than 3 mm. Several clinical parameters, including horizontal probing depth (HPD), vertical probing pocket depth (PPD), vertical relative attachment level (V-RAL), and relative gingival margin level (RGML), were measured at baseline level, along with 6 and 12 months after surgery.

Treatment was given in three groups:

(1) EMD + BG + GTR.
(2) BG + GTR.
(3) open flap debridement (OFD).

The results

The showed significant reduction in the mean HPD after 12 months in the EMD + BG + GTR group (2.10 ± 0.99 mm) and the BG + GTR group (1.50 ± 0.52 mm), while HPD reduction was not significant in the OFD group (0.50 ± 0.70 mm). PPD was reduced significantly in all three groups. The amount of PPD reduction was significantly greater in EMD + BG + GTR (1.74 ± 1.00 mm) compared to BG + GTR (0.81 ± 0.31 mm), as well as OFD (0.46 ± 0.52 mm).

Similarly, V-RAL gain in EMD + BG + GTR (2.12 ± 1.07 mm) was statistically significant compared to BG + GTR (0.85 ± 0.31 mm) and OFD (0.34 ± 0.74 mm). Finally, the number of class II furcations that clinically closed or converted to class I was much more in EMD + GTR + BG group (10 defects) than in BG + GTR (8 defects) and OFD (2 defects).

Chapter 4

Conclusion

Regenerative periodontal procedures seems to be predictable at long term when proper biomaterial is used. When good oral hygiene and rigorous recall program are implemented, the results of regenerative therapy can be maintained with good stability of attachment level and high long-term survival rates of teeth.

GTR with barrier membranes is the technique with more clinical evidence about its effectiveness. Non-bioabsorbable and bioabsorbable membranes are predictable in terms of CAL gain and PPD reduction compared to open flap debridement alone. However, non-bioabsorbable membranes present more postoperative complications and need a reentry surgery for membrane removal. The use of bone graft associated with membrane adds some benefits for treatment, specifically in two-wall bone defects and when a collagen membrane is used.

The use of EMD also presents benefits in terms of clinical parameters. Advantages of this material are the conservative flap opening due to its gel form, handling simplicity and less morbidity for the patient. However, bone defect anatomy is important for its previsibility, and GTR is indicated for three-wall bone defects or narrow two-wall bone defects.

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