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President's message

The Annual Conference of SPIK is planned in a much different way than the previous 15 years. The theme of the Conference is "All About Implants", a new concept in which we have allowed the participation of other organizations like Cochin Periodontists Society and Indian Dental Association Kerala state branch , same time keeping our societal activities unique in the way we usually carry on. It is a two-day program comprising of 14 different lectures by eminent faculties in their specialized fields. All the 300 delegates will be provided with a hands-on experience including placement of implants, the various prosthetic steps, basal implantology and guided implant placement.

The very idea behind this concept is to showcase implantology as a specialty and even allowing undergraduate students to have a taste of the immense potential that implantology as a science has to offer.

As I come to the end of my term, I would like to place on record the contributions from Executive committee in conducting various SPIK activities across the state. I also take this opportunity to congratulate the Editorial team for bringing out all JSPIK issues in the stipulated time.

Wishing all the Periodontists across the state a wonderful new year and a happy SPIK 2024!

Dr. Jose Paul
President, SPIK

Secretary's Message

Welcome you all to the third issue of our Journal - 'JSPIK' ….

At the outset, let me wish all members a Happy and Prosperous 2024 !

SPIK is an excellent scientific learning platform for all postgraduate students. I would like to congratulate the organizing committee of 16th SPIK Annual Conference to be held at Ernakulam on 10th & 11th of February. This two day Convention on "All About Implants" would be one among the best Implant conferences to be held at National level.

Congratulations to Dr. Deepak Thomas, Scientific Convenor for coordinating various activities of SPIK in an exemplary manner.

Let me congratulate our Editor , Dr. Shahana C Mohamed for publishing the third issue of our journal of this SPIK year. All the contributions were subjected to a blind scrutiny by peer reviewers before acceptance for publication.

The term of the office is coming to the flag end. I would like to extend my sincere thanks to all members for their support and encouragement given throughout. Your creative ideas, positive suggestions and healthy criticism has definitely improved our SPIK activities.

Special gratitude to our dear President Dr. Jose Paul, Immediate Past President Dr. Presanthila Janam, Past Secretary Dr. Jayan Jacob Mathew and all the members of the Office and the Executive Committee.

Dr. Mohammed Feroz T.P
Secretary, SPIK

Editorial

Greetings from the editor…

As my two-year term as Editor draws to a close, I would like to thank all the authors and reviewers of JSPIK for their contributions during this time. Thanking our Immediate Past President and my teacher Dr. Presanthila Janam for entrusting me with this great responsibility of being editor of this esteemed journal. This was indeed a fruitful tenure and I hope I have fulfilled my role fairly well.

Congratulations to the organizing committee of the 16th SPIK Annual Conference to be held on February 10 and 11, 2024 at Kochi. This two-day convention, with the theme "All About Implants", would be one of the most important implant conferences to be held nationally.

I am indebted to our outgoing President Dr Jose Paul, our secretary Dr. Mohammed Feroz, and all members of SPIK office for their constant support. I hope that during the tenure of our new President, further steps will be taken to advance our journal to the next level. My humble request to all our members: please continue to support JSPIK with your scientific contributions.

Dr Shahana C Mohamed
Editor, JSPIK

JSPIK

Aesthetic Crown Lengthening for Patient Satisfaction- A Review with Case Reports

Sapna Balakrishnan[1], Hiba Fathima C[2]

ABSTRACT

The appearance of gingival tissue surrounding the teeth plays a significant role in determining the aesthetics of maxillary anterior region. Patients have a greater desire for better aesthetics which influences their choices of treatment. Crown lengthening can be carried out for aesthetic enhancement as-well-as prosthetic and restorative purposes. The procedure involves various techniques such as gingivectomy, apically positioned flap and osseous resection. The biologic width is reestablished by these methods. Other factors to be considered include amount of keratinised gingiva, crown to root ratio and ferrule effect. This article reports two cases - a case of anterior aesthetic surgical crown lengthening under local anaesthesia and the desirable outcome achieved. The second case report is of crown lengthening used for restorative and prosthetic purpose with ostectomy.

Keywords: Crown lengthening, Gingivectomy, Biologic width

Introduction

Patient's smile can influence his or her perceived beauty.[1] The teeth have a great impact on improving the physical appearance and self-esteem of patients.[2] Aesthetically driven treatment planning depends on the position of the teeth and architecture of gingival tissue. The abnormalities in symmetry and contour can significantly affect the harmonious appearance of natural dentition. Excessive gingival display or shorter crown can severely compromise the appearance of the individual. A conservative display of approximately 2-3mm of marginal gingiva is generally considered as part of the ideal aesthetic smile.[3] The concept of crown lengthening was introduced by D.W. Cohen in 1972.[4] Clinical crown lengthening refers to procedures designed to increase the extent of supra-gingival tooth structure for restorative or aesthetic purposes. It is based on two principles: biologic width and keratinised gingiva.

Biologic Width

The concept first originated from research conducted by Garguilo, Wentz and Orban.[5] In periodontal health, biologic width, was reported to be an average of 2.04 mm, where approximately 0.97 mm is occupied by the junctional epithelium and 1.07 mm is occupied by connective tissue attachment to the root surface.(Figure 1) In the recent classification by World Workshop 2017, the term biologic width is replaced by "supracrestal attached tissues" consisting of junctional epithelium and supracrestal connective tissue attachment.[6]

Impingement on the biologic width by the placement of a restoration within its zone may result in: [7]

- Gingival recession, pocket formation and alveolar bone loss
- Crestal bone loss inferior to the encroaching margin
- Gingival inflammation

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This occurs as the body attempt to re-create room between the alveolar bone and the margin to allow space for tissue attachment. Trauma from restorative procedures can play a major role in causing this fragile tissue to recede.

Keratinised Gingiva

An adequate width of Keratinised gingiva (≥2 mm) should be maintained around a tooth for gingival health.[8] The surrounding soft tissue should be considered carefully when tooth form or size has to be altered. The accuracy of measurement before crown lengthening is affected by the biotype of the gingiva, the presence of recessions, the shape of root surface, bone dehiscence and the thickness of alveolar bone.[9]

Indication for Crown Lengthening Surgery [10]

1. Subgingival tooth fracture
2. Subgingival caries
3. Altered passive eruption
4. Presence of short crown
5. Restorative requirements
6. External root resorption

Techniques for Crown Lengthening [10,11,12]

a. Gingivectomy- conventional, laser, electrocautery
b. Internal bevel gingivectomy/ flap surgery with or without ostectomy
c. Apical positioning of flap with or without ostectomy
d. Combined technique (surgical and orthodontic)

Pre-Surgical Analysis

The following are the pre-surgical clinical analysis prior to crown lengthening procedures:[13]

- Determine or anticipate the finish line prior to surgery
- Bone sounding prior to surgery is performed to establish the biologic width in surgical site and contralateral site
- The combination of biologic width and prosthetic requirements determines the total amount of tooth structure necessary for exposure
- Assessment of crown to root ratio
- Tooth structure topography, anatomy, and curvature are analysed for determining osseous scallop and gingival form

The following is a series of three case reports done in the Dept of Periodontics, Government Dental College, Pariyaram, Kannur after getting appropriate informed consent from the patient.

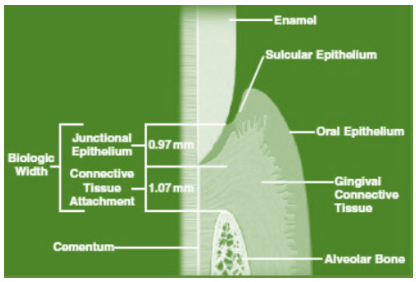

Figure 1: Biologic Width

Figure 2

Figure 3

Figure 4

Figures 2,3,4: Pre-operative view

Figure 5: Adequate width of attached gingiva

Figure 6:Internal bevel incisions on teeth # 11,12

CASE REPORT-1

A female patient aged 19 years (Patient 1) reported to the Department of Periodontics, Government Dental College, Pariyaram, Kannur with a chief complaint of gummy smile and spacing between the teeth.(Figures 2,3,4) Her medical history was non-contributory, with no history of smoking or alcohol consumption.

Intra oral examination revealed excess gingival visibility and short clinical crown height in maxillary incisor teeth #11, 21 (measured 7mm). (Figure 5) Generalised spacing was seen in maxillary anterior region and papillary attachment of maxillary labial frenum. (tension test positive).

On clinical examination, pocket depth of 4 mm is seen in relation to teeth # 11, 21. Hence it is assumed that the biological width of 2.04 mm was maintained therefore there was no need of osseous recontouring in this case. Thus, removal of excess gingiva with proper gingival contouring with gingivectomy was planned.

Local Infiltration anaesthesia was given in maxillary anterior labial region. Internal bevel incision was made in relation to teeth # 11, 21 region using No.15 scalpel and 2mm of marginal gingiva was excised to increase the crown length of teeth # 11, 21 to a total of 9mm.(Figure 6)

Maxillary labial frenum is engaged within artery forceps. Using No.15 blade, incision is made in the lower and upper part of the artery forceps and frenum was excised. (Figure 7) Interrupted suture was given to approximate the wound edges. (Figure 8)

Periodontal dressing was placed over surgical site. Patient was given post-surgical instructions and was prescribed Amoxycillin 500mg three times daily

Figure 7: Excision of frenum

Figure 8: Sutures placed

Figure 9

Figure 10

Figures 9,10: One-month post-operative view

Figure 11: Pre - operative view

Figure 12: After extraction of teeth # 11,21

Figure 13: Probing depth after alveoloplasty

Figure 14: Incisions placed

Figure 15: Full thickness flap with

and Aceclofenac 100mg twice daily for five days. Patient was reviewed after one week and sutures were removed. Patient was referred to Orthodontic department for correction of spacing.

She was reviewed after one month and healing was found to be satisfactory. Patient was satisfied with the improvement in her smile. (Figures 9,10)

CASE REPORT-2

A 55 years old female patient reported to the Department of Periodontics, with complaint of pain and swelling in the gums. Her medical history was non-contributory, and she did not have any oral deleterious habits. Dental examination revealed that her teeth # 11,21 had root caries and were grade III mobile. (Figure 11) Teeth # 12,22 were supraerupted but not mobile. Periodontal examination revealed poor oral hygiene with sufficient width of attached gingiva. A treatment plan was formulated to extract teeth # 11,21 (Figure 12) and after Phase I, to perform crown lengthening in relation to teeth # 12,22 to increase the supragingival tooth structure and to place fixed prosthesis in relation to teeth # 13 to 23 region so as to allow a healthy, optimal relationship between the restoration and periodontium. Patient was informed thoroughly the pros and cons of surgical technique, and informed consent obtained.

After giving local infiltration anesthesia on the maxillary anterior labial side and nasoplatine nerve block, transgingival probing was done (Figure 13). The level of incision was marked by placing bleeding spots using a Krane Kaplan pocket marker. Using a No. 15 BardParker blade, the initial internal bevel incision was performed 3 mm above the gingival margin to achieve the ideal contour both on labial and palatal aspect (Figure 14). Since, sufficient amount of attached gingiva was present, we didn't have to go for an apically repositioned flap. Then, a mucoperiosteal flap was raised (Figure 15). Osseous resection was performed using low speed handpiece and carbide bur under copious saline irrigation to maintain the biologic width (Figure 16).

Additionally, two mm of bone was further reduced to gain the ferrule effect. The flap was repositioned and sutured (Figure 17). A temporary fixed partial denture (FPD) was fixed during the healing period. Chlorhexidine rinse 0.2% twice daily was prescribed for twice weeks, and the patient was given appropriate postoperative instructions. Suture removal done after one week (Figure 18). After two month the patient was recalled and final tooth preparation done and final FPD restoration placed. (Figures 19, 20)

Figure 16 ostectomy respect to teeth # 12, 22

Fig-17: Flap is apically repositioned and sutured

Figure 18: Temporary crown fixed

Figure 19: Immediately after suture removal

Figure 20 Two-month post-operative view

Figure 21: Two-month post-operative view

CASE REPORT - 3

A 35- year old female patient came with the chief complaint of damaged maxillary fixed denture which was placed many years back to replace front tooth that was lost in an accident. On examination patient was having fixed partial denture in relation to teeth # 14 to 21 region with teeth # 13 and 11 missing. The crown height of teeth # 11,21 were uneven , ceramic facing was chipped off and patient had an unesthetic appearance (Figure 22). Medical history was non contributory. After Phase - I, the FPD was removed and surgical crown lengthening done in relation to teeth # 21 and 12 (Figure 24) . Mucoperiosteal flap was opened and one mm bone was removed on the buccal aspect of teeth # 21 and 12 and flap replaced and suture placed. After healing crown height of abutment teeth were increased by one mm (Figure 25). Abutment were prepared for new crowns and FPD in relation to teeth # 14 to 21 was placed. Patient was satisfied with the new improved appearance. (Figure 26).

Discussion

The achievement and maintenance of ideal gingival margin levels and architecture constitute essential requirements for aesthetic crown lengthening procedure. Biologic width is the zone of the root surface coronal to the alveolar crest to which the junctional epithelium and connective tissue are attached. The physiologic location of the biologic width can vary with age, tooth migration due to loss of arch or orthodontic treatment. Crown lengthening procedure invading the biologic width can have deleterious effect on periodontium leading to gingival inflammation, loss of attachment and alveolar resorption.

- The techniques of surgical crown lengthening are:
- External bevel gingivectomy
- Internal bevel gingivectomy with or without bone reduction
- Apically positioned flap with or without bone reduction
- Combined technique (surgical and orthodontic)

The optimal technique is based on the hard tissue and soft tissue parameters which are recorded first to evaluate the requirements of the case.

There are also various means of performing crown lengthening surgery like scalpels, cautery, and laser. It has been seen that healing with laser is faster than scalpels. Also post operative discomfort is lesser with laser as compared with scalpels.[14]

Violation of the biologic width is a common occurrence in the practice of restorative dentistry

Figure 22: Pre-operative view

Figure 23: After prosthetic crown removal

Figure 24: After surgical crown lengthening

Figure 25: Healing after suture removal

Figure 26: Post-operative view

especially during placement of a deep subgingival restoration. During the clinical procedure, crown to root ratio needs to be maintained in 1:1 ratio minimally. Ferule effect is also an important criterion which the operator needs to keep in mind while carrying out the procedure.

The cases discussed here have been treated with surgical technique to achieve restorative, prosthetic and aesthetic needs of the patient. All cases were treated such that there is no violation to biologic width that can have deleterious effect on periodontium leading to gingival inflammation, loss of attachment and alveolar resorption.

CLASSIFICATION OF AESTHETIC CROWN LENGTHENING[15]

Ernesto has proposed the following classification (Table-1):

Type I- It characterized by sufficient gingival tissue coronal to the alveolar crest, allowing the surgical alteration of the gingival margin levels without the need for the osseous recontouring. A gingivectomy or gingivoplasty will usually suffice to establish the desired gingival margin position while simultaneously avoiding the violation of biologic width.

Type II- It is characterized by soft tissue dimensions that allow the surgical repositioning of the gingival margin without osseous recontouring but nevertheless in violation of the biologic width. This type basically consists of staging of crown lengthening procedure in two stages i.e. stage 1 and stage 2. In stage one, a gingivectomy procedure is done and required amount of crown is exposed. Once the tissues are healed stage 2 procedure is done, in which, a flap surgery is done and required amount of ostectomy is done to maintain the biologic width.

Table-1: Classification Crown Lengthening

	CHARACTERISTICS	ADVANTAGES	DISADVANTAGES
TYPE 1	Sufficient soft tissue allows gingival exposure of the tooth without exposure of the alveolar crest and violation of biologic depth	May be performed by the restorative dentist provisional restorations of the desired length may be placed immediately	
TYPE II	Sufficient soft tissue allows gingival excision without exposure of the alveolar crest but in violation of the biologic width	Will tolerate a temporary violation of biologic width, allows staging of the gingivectomy and osseous contouring procedures. Provisional restorations of the desired length may be placed immediately	
TYPE III	Gingival excision to the desired clinical crown length will expose the alveolar crest	Staging of the procedures and alternative treatment sequence may minimize display of exposed subgingival structures. Provisional restorations of desired length may be placed at second stage gingivectomy	Requires osseous contouring. May require a surgical referral. Limited flexibility
TYPE IV	Gingival excision will result in inadequate band of attached gingiva		Limited surgical options. No flexibility. A staged approach is not advantageous. May require a surgical referral.

Type III- In type III bone sounding may reveal a scenario where repositioning of the gingival margin will result in the exposure of the osseous crest. It is inappropriate to refer these patients without providing a surgical template derived from a relevant aesthetic blue print. This template would serve as a guide during surgery so that following flap reflection, a constant relationship between anticipated clinical crown and the osseous crest levels, can be established and maintained through bone cutting procedure. Flaps should also be repositioned coronally, rather than apically, to maximize tissue preservation and allow the anticipated revisions to the gingival margins that will follow once the healing from the osseous surgery has been completed. Following adequate healing, a gingivectomy may be performed to establish the definitive gingival position without the risk of violating the biologic width.

Type IV- This type is reserved for scenarios where the degree of gingival excision is compromised by an insufficient amount of attached gingiva. Ideal margin position, therefore, can only be achieved by an apically position mucoperiosteal flap, with or without osseous contouring.

Crown Lengthening is a surgical procedure that requires exposure of adequate tooth structure for restorative procedures. Various techniques and methods used for performing Crown Lengthening should be treated in such a way so as to avoid any violation to biologic width that can have deleterious effect on periodontium leading to gingival inflammation, loss of attachment and alveolar resorption.[16]

Conclusion

The establishment of ideal gingival margin architecture requires precise sculpting of the soft tissues. This report presents a few cases of crown-lengthening procedure for aesthetic, restorative and prosthetic reasons. It is useful for enhancing maxillary anterior aesthetics and to provide tooth length for proper restoration of a tooth. Crown lengthening may be as simple as a limited removal of soft tissue or as complex as orthodontic extrusion followed by flap with osseous surgery on a tooth requiring endodontic therapy. Crown lengthening is contraindicated, if the aesthetics is compromised, crown-root ratio is altered, non-restorable caries/ root fracture/ insufficient restorative space is present.

Careful evaluation, case selection, treatment planning and surgical treatment are required to achieve results that meet the functional and esthetic challenges. Predictable long-term restorative success also requires a combination of restorative principles with the correct management of the periodontal tissues.

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A Review of Potential Errors Determining the Outcome of Gingival Augmentation Procedures

Viji Lalithambika Nadaraj[1], Khyati Arora[2], Harikumar K[3], Smitha P S[4], Sakeer Hussain[5]

ABSTRACT

Several techniques have been proposed for root coverage surgeries, to date. The coronally advanced flap and tunnel techniques are routinely done to cover exposed root surfaces. Complications can occur during the surgical procedure and postoperatively. Errors in treatment planning and technique can also contribute to the occurrence of complications. Precise presurgical evaluation of a patient's history of disease and risk elements can reduce complications during the procedure to some extent. Theoretical knowledge and practical skills in surgical procedures help to avoid treatment errors and complications. In this review various complications and treatment errors commonly occurring during root coverage surgeries and measures to avoid /reduce such complications are enumerated.

Keywords: Root coverage techniques, Complications, Errors, Management

Introduction

Gingival augmentation procedures are periodontal plastic surgical procedures indicated for the treatment of reduced keratinized tissue width and thickness. These defects may be associated with root hypersensitivity, carious/non-carious cervical lesions, and impairment in aesthetics and oral hygiene maintenance. Different techniques employed for gingival augmentation can result in acceptable and untoward clinical outcomes (Figure 1,2).[1] Till now, several techniques have been proposed for gingival recession treatment.[2-6] Complications can occur during surgery and post-operatively. Errors in treatment planning and execution contribute to the occurrence of complications.

This review aims to focus on treatment errors, complications, or side effects that arise during presurgical, intra-surgical, and postsurgical phases of root coverage procedures and how to prevent and manage these issues and thus improve the outcome of these procedures.

ERRORS IN PRESURGICAL PHASE

Errors In Diagnosis

A chance of misdiagnosis of gingival recession occurs when the teeth adjacent to the "elongated tooth" are affected by the altered passive eruption resulting in apparently short clinical crowns.[7]

Errors in assessment of Prognosis

In Miller class III and Miller class IV, only partial and no root coverage can be expected. In Miller class I/II recessions, complete root coverage can be expected. We can improve the limited root coverage outcomes if the factors affecting maximum root coverage are appropriately evaluated and modified; that is, loss of interdental papilla height, presence of tooth rotation, tooth malposition, tooth extrusion, and cervical abrasion defects.[8,9] By calculating the ideal vertical dimension of the interdental papillae of the tooth with the recession defect, it is possible to predetermine the position of the soft tissue margin after root coverage surgery.[8,10]

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Errors in treatment planning

Treatment planning implies thorough knowledge of the patient's preferences, the accurate diagnosis, the etiology of the problems, the prognosis, and the management options to reduce treatment errors. Accurate estimation of risk factors or diseases is inevitable in reducing complications and errors during the surgery. Bad habits should be identified during the presurgical evaluation. An incorrect toothbrushing method has been proposed as the most critical mechanical factor leading to the development of gingival recessions.[11-15] Incorrect toothbrushing methods should be modified through motivation and proper oral hygiene instructions. At sites with thin gingival phenotype, inflammation causes gingival recession development.[16-18] Poor oral hygiene also negatively affects the success of root coverage procedures.[19] Smoking is another patient-related factor that can affect the wound healing process due to the alteration of gingival tissue vascularization, immune and inflammatory responses, and healing potential of the periodontal connective tissues.[20,21] Treatment plan for gingival augmentation should modify all the above mentioned factors.

ERRORS IN THE INTRASURGICAL PHASE

A less experienced operator is responsible for a greater number of errors and complications during the surgical procedure—which could alter the course of wound healing to some extent.

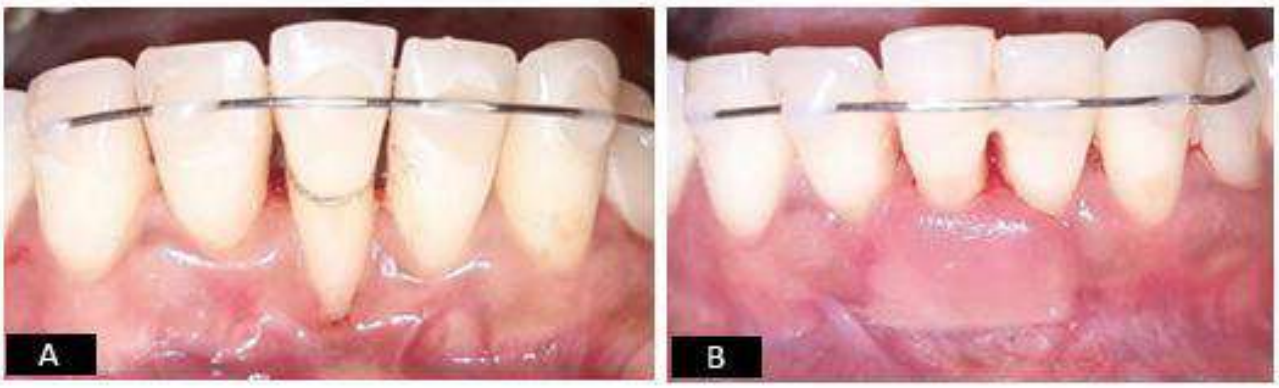

Fig 1 Gingival augmentation (A)Pre-operative (B)Post-operative

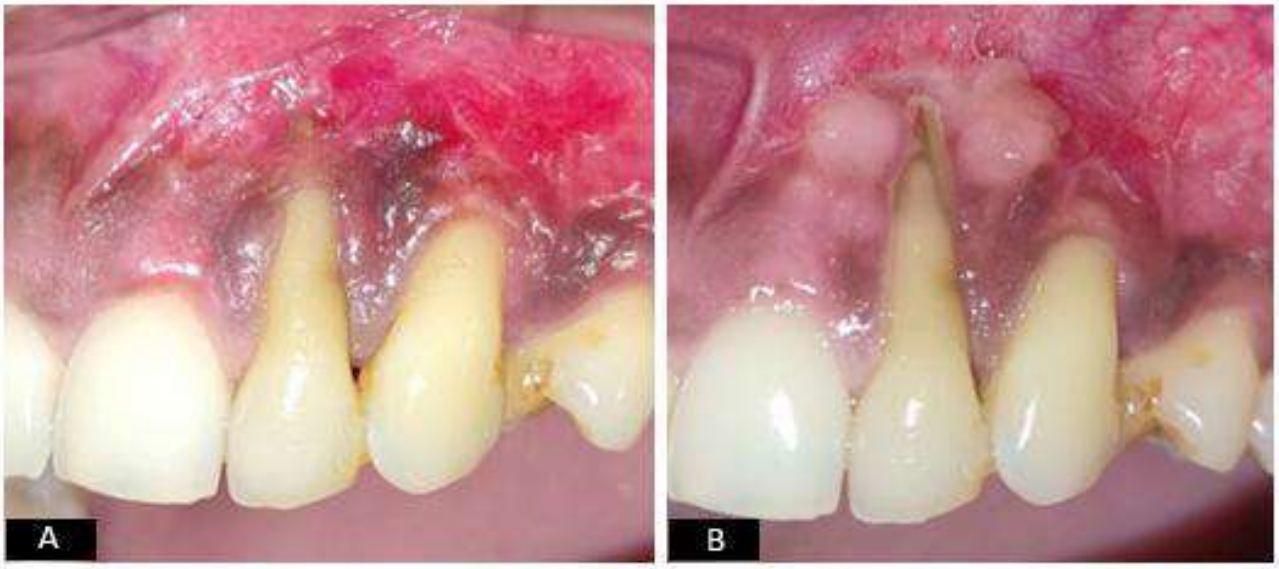

Fig 2 (A)Pre-operative (B)Post-operative

OUTCOMES OF GINGIVAL AUGMENTATION PROCEDURES

a. Improper soft tissue management at the recipient site

Increased bleeding can result from errors made when carrying out flap incisions. The correct execution of split-thickness incisions avoids damaging larger vessels located in the submucosal layer and the muscular structure. Perform the split-thickness incisions at the beginning of the surgery immediately after full-thickness flap elevation, and afterward, bleeding is controlled by keeping a gauze in place to protect the flap until the time of the suture. Removal of all epithelial tags at the site is mandatory.

b. Improper soft tissue management at the donor site

Chances of bleeding are rare during harvesting of graft and can be due to inappropriately performed harvesting of graft from the palate, which may cause greater palatine artery injury. Local anesthetics containing vasoconstrictors like epinephrine (1:100000 or 1:200000) provide better visualization of the surgical field and less bleeding in addition to providing excellent pain control.

Intraoperative hemostasis is achieved by applying pressure to the surgical site for 3-5 minutes with a gauze dressing, either dry or soaked in hemostatic agents.[22] Tranexamic acid is one of the most frequently used hemostatic agents.

c. Improper management of flap at the recipient site

The most relevant technical error that can be committed during soft tissue manipulation, is flap perforation. Direct injury to the integrity and vascularization of the soft tissues resulting in flap perforation, more likely to appear when performing the split-thickness incisions.[23] Flap perforation compromises its blood supply, leading to necrosis and affects the survival of the underlying connective tissue graft. Root coverage outcomes are also affected. During the surgical phase, manage the perforation with a full-thickness approach and proceed with flap mobilization apical to the perforation in a split-thickness manner without increasing its dimensions. This reduces tension at the level of the perforation when it is small (ie,1-2 mm) and located on top of a vascular bed (connective tissue or periosteum) and sutures are not needed. If the perforation is greater than 2 mm or lies on an avascular area like a root surface, close it using simple interrupted sutures with a small needle to avoid further damage to the soft tissues. A closure of flap perforation should be performed at the end of the surgery to reduce tension at the level of the flap margin and the risk of perforation opening.[23]

d. Improper management of graft

The survival of the graft is correlated to its thickness. Too thin a flap may determine vascular distress and consequent tissue necrosis. In the case of a free soft tissue graft placed over a denuded root surface, healing depends on the diffusion of plasma and subsequent revascularization from those parts of the graft resting on the connective tissue bed surrounding the dehiscence. The establishment of collateral circulation from adjacent vascular borders of the bed allows the bridging of the graft. Proper graft adaptation to the underlying periosteum is important. After suturing, slight pressure is applied to the graft with gauze moistened with saline for few minutes to permit fibrin clot formation, reduce thickness of the clot and prevent bleeding. Bleeding will result in thick clots under the graft which will impede plasmatic diffusion in the early healing period and subsequent necrosis of the graft/flap. Graft movement as a result of inadequate or insufficient suturing will result in failure of the graft due to impaired plasmatic diffusion.

e. Error in suturing

The best clinical outcomes, in terms of root coverage, are achievable when the flap is passively adapted and sutured without tension over the exposed root surface. Sling sutures are the most precise way to position a flap coronally because the flap is attached to a fixed anchor point, the tooth. The tight marginal adaptation is essential for promoting wound healing and blood clot stabilization. The less the trauma, the lower the chances of flap dehiscence. Sutures anchored to the underlying periosteum, if performed at the level of the alveolar mucosa, may lead to the formation of white and flat scars.[23]

ERRORS AND COMPLICATIONS IN POSTSURGICAL PHASE

Common errors which can happen in postsurgical phase are

i) Improper postoperative instructions

ii) Poor soft tissue handling during healing phase by patient

iii) Improper wound management during healing phase

iv)Error in timing and method of suture removal

Early bleeding of primary site

An insufficient number of platelets results in blood clotting disorders, leading to bleeding from the surgical site. Deficiencies of various clotting factors occur in liver disease, renal insufficiency, fibrinolysis, disseminated intravascular coagulopathy, leukemia, pharmaceutical agents, and genetic disorders, causes abnormal blood coagulation. Secondary hemorrhage (occurring 24 hours after surgery) due to several factors: intrinsic trauma, presence of foreign bodies, premature suture loss, or inadequate marginal stability of the flap that may cause repeated, delayed organization of blood coagulum. Vasoconstrictors included in the local anesthetic (ie,1:80000 epinephrine) may produce rebound vasodilatation after the vasoconstriction effect has worn off, leading to increased risk for bleeding in the immediate postoperative period. Pressure is applied to the area of bleeding by interposing a gauze between the flap and lip/cheek, either dry or soaked with a hemostatic agent, to stop bleeding. If suture loss occurs prematurely, new sutures should be placed to attain flap stability.[23]

Pain

In root coverage procedures, postoperative pain is mostly related to soft tissue harvesting from the palate. The apico-coronal dimensions and thickness of the graft may have more influence on perceived pain. Pain management after root coverage procedures is usually achieved with nonsteroidal anti-inflammatory drugs immediately after the surgery and recommended in the following days according to the patient's needs.

Swelling

Swelling is considered a normal reaction to surgery and is part of the body's repair process. Swelling will reach its peak within 2-3 days postoperatively, typically subsiding within 4-5 days. Swelling occurrence was found to be more likely in smokers (three times) than in nonsmokers, especially when bilaminar procedures with autogenous grafts were adopted (Griffin et al).[24] The intake of pain killers with an anti-inflammatory effect combined with cryotherapy in the immediate postsurgical phase help to control swelling and pain.

Flap dehiscence

The first 14 days after root coverage procedures are crucial in terms of flap stability for successful wound healing. Early flap dehiscence defined as a condition in which two layers, previously stitched together, separate or rupture, is a complication during this time. The first key factor for reducing the risk of flap dehiscence is the adequate management of flap tension. The best clinical outcomes, in terms of root coverage, are achievable when the flap is passively adapted and sutured without tension over the exposed root surface. The second crucial aspect for reducing the risk of flap dehiscence when performing a coronally advanced flap is the appropriate de-epithelialization of the anatomical papillae, leaving as much connective tissue as possible. Thus, ensuring vascular exchange and the survival of the marginal aspect of the flap. The last crucial aspect for reducing the risk of flap dehiscence is optimal wound stability through an effective suturing technique. Minimally invasive techniques such as sharper and finer surgical blades, together with smaller suture material and magnification, can lead to less tissue trauma. The less the trauma, the lower the chances of flap dehiscence.

Graft/biomaterial exposure

The combination of a coronally advanced flap and a connective tissue graft is the gold standard for achieving the best root coverage. One of the main complications with this technique is graft exposure during the postoperative period. This may occur prematurely (within the first 1-2 months after the surgery) or be delayed. There will be an unpleasant appearance due to lighter tissue color and/or a different texture in comparison to neighboring soft tissues. To avoid premature graft exposure, it should be secured at the level of the cemento-enamel junction or slightly apical to it, but never coronally. Less early flap shrinkage has been reported by reducing the graft dimensions. Flap margins should be positioned 1-2 mm coronal to the cemento-enamel junction to obtain greater root coverage and to avoid graft exposure by compensating for the postoperative flap shrinkage. Despite a well performed surgery and excellent healing, graft exposure is possible 9-12 months after surgery. This can lead to

altered appearance of the treated soft tissues. To solve the patient's esthetic concerns, surgical reinterventions such as gingivoplasty, removal of the exposed part, and performance of a second root coverage surgery are the treatment options. Connective tissue substitutes can reduce postoperative morbidity by avoiding a second surgical site in root coverage procedures. In the case of matrix exposure during the postoperative period, contrary to the connective tissue graft, it tends to resorb. But the recurrence of gingival recession can occur.

Scars/keloid-like formations

Scar tissue is characterized by excessive accumulation of disorderly arranged collagen (mostly type I and III), proteoglycans, and persistent myofibroblasts.[25] Incisions or sutures performed in alveolar mucosa can lead to scar formation. Sutures anchored to the underlying periosteum, if performed at the level of the alveolar mucosa, may lead to the formation of white and flat scars. In root coverage procedures, keloid-like formation results due to soft tissue hyperplastic response along vertical releasing incisions or periosteal incisions at the level of alveolar mucosa. Their characteristics include a difference in volume, color, and texture compared with the adjacent areas that may have a negative impact on aesthetics. To minimize scar tissue formation, vertical incisions should be done as short as possible, avoiding placing them on buccal root prominences and bevelled so that the bone and periosteal tissues are not included in the superficial cut and thus do not participate in the healing process.

Flap/graft necrosis

When a small amount of blood flows to the tissue, necrosis may occur. In root coverage procedures, tissue necrosis may involve the pedicle flap, the connective tissue graft in bilaminar techniques, and the free gingival graft. An inadequate flap design such as reduced base of the pedicle flap and/or thickness such as too thin flap may determine vascular distress and a consequent tissue necrosis. In the case of a free soft tissue graft placed over a denuded root surface, healing depends on diffusion of plasma and subsequent revascularization from those parts of the graft resting on the connective tissue bed surrounding the dehiscence. The establishment of collateral circulation from adjacent vascular borders of the bed allows bridging of the graft. The survival of the graft is correlated to its thickness. Adequate pedicle flap design considers specific characteristics—such as surgical papillae with appropriate dimension and thickness, vertical releasing incisions parallel or slightly divergent, and proper flap thickness—to reach an overall suitable flap vascularization.

Infection

In root coverage procedures, wound infection could occur due to the oral environment in conjunction with flap fixation and suturing techniques. Factors promoting infection are wound bacterial count ($>10^5$ / gm tissue), circulatory collapse, injury and dead space. Using a strict aseptic technique, syringe irrigation to remove bacteria during wound cleansing, removing possible foreign bodies, and careful debridement of all teeth are prerequisites for proper surgical interventions to prevent wound infection. Performing rinses with 0.2% chlorhexidine digluconate solution for 1 minute immediately prior to periodontal surgery has been recommended to reduce bacterial load in the oral cavity.

UNTOWARD CLINICAL OUTCOMES

External root resorption

Flap elevation is recommended for adequate visualization of the entire lesion and its restoration. The restoration must be as smooth as possible to allow the reattachment of connective fibers of the flap's inner aspect above the root surface.

Exostosis

It is a benign condition that must be identified and differentiated from a malignant tumor, such as osteosarcoma. Corroboration of treatment along with palpation, horizontal sounding, and an occlusal radiographic view will help the practitioner in establishing a correct diagnosis and give the patient reassurance.

Cyst-like formation

The origin of these lesions may be due to epithelial remnants embedded under the overlying flap. The cyst-like formations are more frequent when the graft has been harvested from the anterior palate, due to the presence of rugae and epithelial invaginations extending into the lamina propria.

Persistence of exudate might require some form of gingivoplasty based on the extension of the lesion.

Residual hypersensitivity

Residual dentinal hypersensitivity after gingival recession treatments may be due to incomplete root coverage with consequent exposure of dentinal tubules to the oral cavity. In the case of minimal remaining recession, the use of desensitizers or placement of composite restorations can be done. More extreme cases of incomplete coverage or recession recurrence normally require surgical reintervention, after 4-6 months.

Incomplete root coverage

Partial and incomplete root coverage should be handled according to the patient's request and complaints. When the treatment errors or complications result in partial or incomplete root coverage, a second surgery is recommended to reach the ideal results.

Conclusion

The outcomes of gingival augmentation procedures depend on several factors influencing preoperative, intrasurgical and postoperative phases. Proper patient evaluation and site diagnosis can avoid many undesirable outcomes. The use of anesthetic with vasoconstrictor is advised during surgery to reduce intraoperative bleeding. Technical errors during flap management correlated with its thickness, extension and passivity, can be avoided. When suturing, proper flap adaptation and first intention wound closure without any residual tension will prevent flap dehiscence and early flap shrinkage. Anti-inflammatory drugs and analgesics along with proper homecare play a crucial role in early stages of healing.

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Decoding Artificial Intelligence - The New Frontier in Periodontics and Dentistry – A Narrative Review

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ABSTRACT

Artificial intelligence (AI) is the field of computer science that aims to create machines or software that can perform tasks that normally require human intelligence, such as reasoning, learning, problem-solving, perception, and language understanding. A fascinating and rapidly evolving field, AI lies at the core of fourth industrial revolution and is the future of innovative technology in the field of health care. With descriptive, diagnostic, predictive and prescriptive data science, medical frontiers are well expanding in horizons of diagnosis as well as treatment planning. It applies to various branches of dentistry too. Medical and Dental education systems are also adopting this inevitable change. AI is among the most promising technology with high accuracy and efficiency provided the data and algorithm is properly trained. Dental practitioners can identify AI as a supplemental tool to reduce their workload and improve precision and accuracy in diagnosis, decision making, treatment planning, prediction of treatment outcomes, and disease prognosis. Augmented reality and virtual reality have already found application in dental education technology. Although there are limitations with regard to ethical issues in data sharing, ambiguous accountability and complexity of integration of neural networks, if we keep the technology beneficial, it will transform our lives by amplifying human intelligence with artificial intelligence. This review paper briefly describes the science behind Artificial Intelligence and its future perspectives in Periodontics as well as Dentistry.

Keywords: Artificial intelligence,Convolutional neural networks, Periodontology

Introduction

The human brain is sometimes referred to as the 'crowning achievement of evolution'. The scientific world has always strived to create a flawless model that mimics the human brain.[1] When a computer emulates the analytical functions, such as "learning and problem solving" abilities of human brain, it is referred to as Artificial Intelligence (AI).[2] Also known as machine intelligence, AI lies at the core of fourth industrial revolution. The convergence of ever-increasing computing power, machine learning and big data analytics is reshaping the world around us and health care field is no exception. With descriptive, diagnostic, predictive and prescriptive data science, medical frontiers are well expanding in horizons of diagnosis as well as treatment planning. It applies to various branches of dentistry too. AI can learn from multimodal data as opposed to the single information source directed at a specific disease to diagnose beyond human abilities.[3] The excellent capabilities and capacities of AI techniques in recognizing important data patterns has led to their widespread experimentation as clinical trial tools, specifically to assist in decision-making for prognosis and projection, as well as in each phase of diagnosis and subsequent therapy.[2] AI with deep learning could potentially assist medical and dental sciences through automatic data mining. The dental applications of AI are widespread with its foot print in diagnosis, decision-making, treatment planning, and

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prediction of treatment outcomes. With the dawn of AI, health care professionals are increasingly relying on computer programs for making decisions as they have become more intelligent, accurate, and reliable.[4] The current review aims at narrating the development of AI and summarising its applications in the field of dentistry and periodontics along with an insight into the future perspectives.

Major milestones in the History of AI

Alan Mathison Turing is considered as one of the early pioneers in the field of AI. A mathematical logician and cryptanalyst during the second world war, he devised the 'turing test' or criteria for whether an artificial computer is thinking which later became the foundation for artificial intelligence and modern cognitive science.[5] In 1957 John McCarthy developed a functional programming language for Artificial Intelligence.[5] In 1959, Arthur Samuel introduced the term "Machine Learning".[6] There was an exponential growth in the field of AI from 1957 to 1974 because of the growth of computer power, its accessibility and AI algorithms which was followed by "AI winters' due to insufficient practical applications and research funding reduction.[7] In the 1980s machine learning was developed which was actually a subset of AI and can be categorised as weak AI.

Science behind AI

AI comprises of Machine learning with predictive analysis and deep learning, Speech (text to speech and speech to text), Vision (Machine vision and Image recognition), Language processing (Classification, translation, and data extraction), Expert systems, Planning and Optimization, Robotics, and many other aspects. Our daily life is already impacted by various office and practice management software with voice command (Intelligent conversational user interfaces like Siri, Alexa) AI assisted bots (for medical dosage, diagnosis and prognosis, appointment scheduling, drug interactions, electronic health records, and imaging) and Physical artificial intelligence (for rehabilitation, telepresence, robotic support surgery and compactible robots for elderly care).[8]

AI can be broadly classified as Strong AI and weak AI. Strong AI can replace human minds and its research needs to be well regulated. Mostly used AI is the weak AI comprising of Expert based systems, machine learning, deep learning, and neural networks. Machine learning is a part of AI that depends on algorithms to predict outcomes based on a dataset. The purpose of machine learning is to facilitate machines to learn from data so they can resolve issues without human input. In machine learning, machine is trained with data as well as answers. AI approach will then tune

Figure 1: Early pioneers of Artificial Intelligence

the algorithm to find a link between data and answer which can be used on new (unseen) data set with remarkable precision. Al has been proven to increase accuracy, efficiency, and precision on par with medical experts more quickly and affordably.[8]

Machine learning constitutes minimum of three layers: the input layer, hidden layer, and the output layer.

Deep neural networks can have multiple hidden layers and can extract features from the imported data without human intervention. The biological neuron system with many connections is mimicked by these neuron networks and is used by its algorithm to comprehend the relationships between attributes and outcomes. Deep learning is a component of machine learning that utilizes the network with different computational layers in a deep neural network to analyse the input data. The purpose of deep learning is to construct a neural network that automatically identifies patterns to improve feature detection.[9] There are different neuron networks like Artificial neural networks (ANN- a structure composed of many small communicating units called neurons organized in layers) Convolutional neural network (CNN -one of the most used subclasses of ANN and most-used algorithm for image recognition) Recurrent Neural networks (RNN) and Generative adversarial network (GAN). Majority dental applications use supervised learning, where the training data consists of large samples with different features.[8]

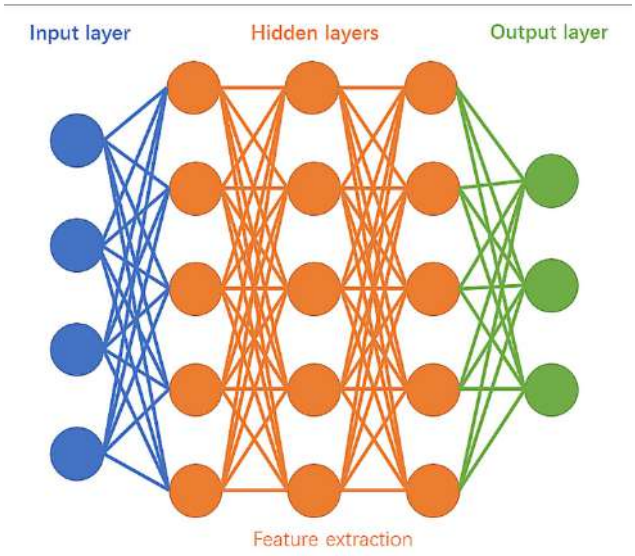

Figure 2: Layers in Machine learning

Terms associated with AI

• Clinical decision support system (CDSS) is a system between a broad dynamic (medical) knowledge database and an inferencing output mechanism that are a set of algorithms derived from evidence based medical practice executed through medical logic modules. Currently, the intuitive interphase with voice controls are designed to assist the health care professional to work more efficiently with time saving and cost effective clinical dental practice.[10]

• Augmented reality is defined as "a technology that superimposes a computer-generated image on a user's perspective of the real world, accordingly giving a composite view".

• Virtual reality is a computer-generated reenactment of a three-dimensional image or environment that can be communicated with, in an apparently real or physical path by an individual utilizing unique electronic equipment.[11]

Applications in Periodontics

Periodontitis is a multifactorial disease with complex relationship to several other physiological systems leading to unfavourable effects on quality of life and general health.[12] These complexities make the study of periodontitis with AI a purportedly better tool. Even though limited there are studies that have tried to explore the various applications of AI in diagnosis and prediction of periodontitis.

AI in diagnosis and differentiating periodontal diseases

Feres et al in 2017, conducted a study by using 40 bacterial species of the subgingival microbiota and a linear Support Vector Machine (SVM) – based classifier to distinguish between periodontal health, generalised Aggressive periodontitis in younger adults and generalised Chronic periodontitis. The study found that SVM could successfully differentiate between health and generalised Aggressive periodontitis and generalised Chronic periodontitis.[13]

Another study in 2017 by Rana, Yauney et al testified that machine learning classifier could distinguish between inflamed and healthy gums. Plaque was recognized using a fluorescent biomarker porphyrin which was irradiated with light of 405-450 nm wavelength and recorded using an oral imaging

device. Plaque was displayed in shades of yellow and orange whereas inflamed gums was displayed in shades of magenta and red. The machine learning classifier could successfully give a pixel-by-pixel segmentation of regions speculated to have gingivitis.[14]

In 2018, Lee et al, steered a computer-aided recognition system where a pre labelled dataset of periapical radiographs were used, to assess the diagnosis and predictability of periodontally compromised teeth (PCT). The diagnostic accuracy for PCT was in the range of 76.7% - 82.6% in predicting hopeless teeth. The results showed that diagnostic and predictive accuracy obtained was similar to that obtained by a board certified Periodontist.[15]

Krois et al, in 2019 used a CNN encoder to discover periodontal bone loss on panoramic dental radiographs. Results showed that within the limited dataset of radiographic image segments, the software performed less accurately than the original examiner segmentation and independent dentists' observers. The authors suggested that the applicability and accuracy of CNNs can be improved by integrating more imaging data such as the use of intra-oral periapical radiographs and data sources such as clinical records into the analytics.[16] Bayrakdar et al in 2020 used CNN to detect alveolar bone loss from dental panoramic radiographic images and found that CNN showed 0.9% accuracy to detect alveolar bone loss.[17]

Table 1: Applications of AI in dentistry[22-24]

Oral Medicine and Radiology	• Diagnosis of caries (Lee et al 2018) • Object detection and semantic segmentation • Risk assessment of Oral cancer (Speight 1995) • Natural language processing to convert chief complaints and history of TMJ disorders (Nam Y, Kim HG 2018) • Treatment recommendations • Prediction of future diseases.
Oral and Maxillofacial surgery / Oral Pathology	• Robotic surgeries • Image guided surgery • Mandibular third molar and Inferior Alveolar Nerve positional relationship detection • Oral potentially malignant disorder diagnosis
Orthodontics	• Diagnosis of the need of orthodontic extraction (Jung and Kim 2016) • Treatment outcome analysis (Patcas et al 2018) • Analysis of radiographs • 3 D aligners • Treatment planning
Endodontics	• Locating minor apical foramen • Success of retreatment • Working length assessment • Root fractures • Root canal system anatomy • Stem cell viability

Haptics-based periodontal training simulator

The first haptics-based dental simulator for periodontics was developed by Luciano et al.[18] This simulator assisted students in developing the necessary skills to diagnose and treat periodontal diseases. A haptic device along with three-dimensional images of upper and lower teeth along with gingiva can be felt by "touch". The resulting haptic feedback replicates the clinical feel of an operator's hand when using dental instruments. In 2007, Steinberg et al incorporated recording and playback of the trainee's performance into the simulator. The advantages of simulator were shortened lesson time, improved learning curve and unlimited practice.[19]

Applications in Implantology

Sadat, Nazari et al in 2016 developed a hybrid method to predict dental implant success using a combined predictive model with various classifiers like Neural networks, SVM and K-Nearest Neighbour (K-NN) algorithm. The authors believed that this model could be a reliable tool to predict the success of the implant prior to the surgery.[20]

Identifying an implant system for implant maintenance always posed a problem for the treating dentist. With AI this identification is possible without depending on the dentist's knowledge or patients reporting. In 2020 Takahashi, Nozaki et al conducted a study using a deep learning-based object detection software to identify implant systems from panoramic radiographs. The authors were certain that this system could help dentists and patients alike suffering from implant related issues.[21]

Applications of AI in Dentistry

An outline of some of the applications in dentistry is given in table 1.

Apart from these applications AI has made its way into practice management, electronic record keeping, AI based dental software for Automated analysis, Image enhancement, prosthesis and smile design. AI has revolutionized medical and dental education technologies also with Virtual reality, Anatomage table (for simulated anatomy dissection), Augmented reality, three Dimensional scanners and study models.

Conclusion

Machine intelligence could be used as an augmentation tool due to its increased accuracy and precision thus assisting the dentists in personalised evidence-based disease management. Along with the integration of imagery and non-imagery data and cross linking among the two, AI has boundless potential in increasing the efficiency of health care system. Despite the challenges of high cost and large storage space AI can be a valuable asset if a proper rapport is built between human and technology. There is need for mechanisms to control the quality of algorithm used which could cause safety issues and ambiguous accountability. Although there are limitations with regard to ethical issues in data sharing and complexity of integration of neural networks, if we keep the technology beneficial, it will transform our lives by amplifying human intelligence with artificial intelligence. AI is still in its relative infancy and has not yet been used to its full potential in the field of periodontology and implantology. With the advantage of improved diagnostic confidence, enhanced data analysis and exactness much could be gained through applying this tool. AI systems show great promise in health care and in the near future it could become a valuable aid to oral health professionals.

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Conflicts of Interest

The authors have no conflicts of interest to declare.

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The Enigma Of Periodontal Disease Pathogenesis – At Zenith or Still to Go?

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ABSTRACT

Periodontitis is a broad term for diseases and conditions of periodontal tissue. Pathogenesis of a disease is the mechanism by which a causative factor (or factors) causes the disease. The search for etiologic agents for periodontal disease started in the golden age of microbiology (1880-1920). Due to recent advancements in periodontal research new models for periodontal disease pathogenesis are proposed consistently. Models of disease pathogenesis aid in amalgamating the data available from current scientific research, which helps in a comprehensive understanding of the disease. The evolution in the knowledge of the pathogenesis of periodontal disease can lead to a revolution in treatment modalities. The purpose of pathogenesis models is to highlight the key aspects that need the main focus. Thus, this narrative review aims to shed light on all the models proposed for the pathogenesis of periodontitis till date and to describe the IMPEDE model (Inflammation mediated polymicrobial emergence and dysbiotic exacerbation) and 'treat to target' model, that is P4 periodontics in detail, which are the most recent concepts proposed till date for periodontal disease pathogenesis.

Keywords: Models, pathogenesis, periodontitis, P4 periodontics.

Introduction

Periodontitis is a chronic multifactorial inflammatory disease associated with dysbiotic plaque biofilms and characterized by progressive destruction of the tooth-supporting apparatus.[1] It is one of the most prevalent oral infectious diseases affecting over 740 million people worldwide.[2] Pathogenesis of a disease is the mechanism by which a causative factor (or factors) causes the disease. The word itself is derived from the Greek words pathos (meaning "suffering") and genesis (meaning "generation"). Periodontitis is a complex interplay between the host, bacteria, and the environment. Bacteria play an essential role in the development of periodontitis. The search for etiologic agents for periodontal disease started in the golden age of microbiology (1880- 1920). Due to recent advancements in periodontal research new models for periodontal disease pathogenesis are proposed consistently. Models of periodontal disease pathogenesis help in integrating the evidence available at that point in time, which helps in a comprehensive understanding of the disease. As depicted by Figure 1 periodontitis has a long and rich history of proposed microbial etiology ranging from nonspecific plaque hypothesis and reaching up to IMPEDE model[3], and the recent concept of P4 periodontics, that is to bring the concept of P4 medicine in periodontics.[4]

HISTORICAL CONCEPT FOR PATHOGENESIS OF PERIODONTAL DISEASE

The search for the etiologic agents of periodontal

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diseases started in the 19th century, during the "golden era" of medical bacteriology (1890–1920) when it was believed that specific pathogens are associated with systemic conditions (no oral pathogens found). Nonspecific and specific plaque hypothesis were delineated in 1976 by Walter Loesche[5], which states that entire plaque flora was responsible for the causation of the periodontal disease and which was later disputed by specific plaque hypothesis which states that certain plaque is pathogenic, and its pathogenicity depends on the presence of or increase in specific microorganisms. Later in 1990, Marsh proposed an ecological plaque hypothesis that combined both specific and nonspecific plaque hypothesis and stated that disease was perhaps related to a microbial imbalance (dysbiosis) caused by ecological stress that enriched disease-related microorganisms.[6] Specific and nonspecific hypothesis were in accordance with a linear model (1960) and over the years new models developed as shown in Figure 1.

KEYSTONE PATHOGEN HYPOTHESIS

Based on findings from the 10-year Human Microbiome Project launched by the National Institutes of Health (NIH) in 2008, the "keystone pathogen hypothesis" was proposed in 2012 by Hajeshingalis.[7] This hypothesis moved one step beyond the ecological stress assumption to propose that the integration of certain low-abundance microbes into the host immune system would result in a remodelling of the microbiota causing periodontal disease. For example, specific pathogen-free mice exposed to Porphromonas gingivalis developed periodontal bone loss even when the pathogen was present in less than 0.1% of the total microbiota. The disease did not occur in the absence of other bacteria (i.e., in germ-free mice) or mice lacking the C3a or C5a complement receptors. These data indicated that P. gingivalis subverts the host immune system as shown in Figure 2 and changes the microbial

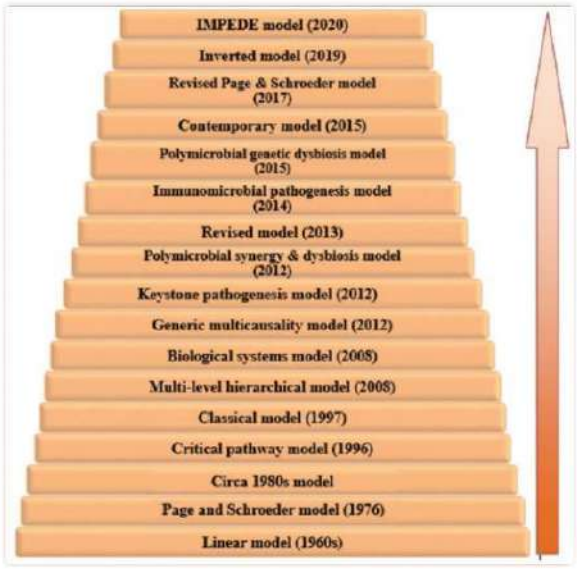

Figure 1. Evolution of periodontal disease pathogenesis models. (Adapted from Avula H, Chakravarthy Y. Models of periodontal disease pathogenesis: A journey through time. J Indian Soc Periodontal. 2022;26(3):204-212.)

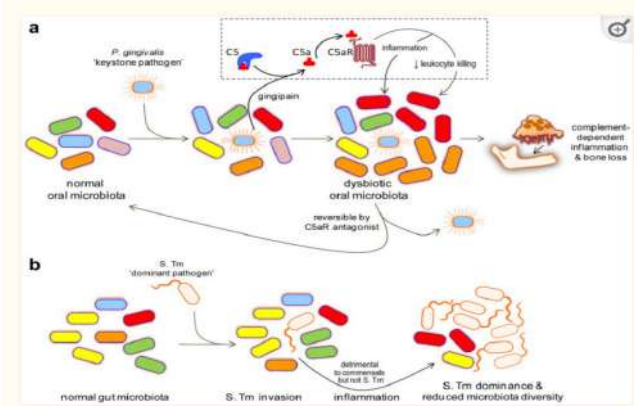

Figure 2. Role of P. gingivalis in everting the host response. (Adapted from Lamont RJ, Jenkinson HF. Life below the gum line: pathogenic mechanisms of Porphyromonas gingivalis. Microbiol Mol Biol Rev MMBR. 1998;62(4):1244-1263.)

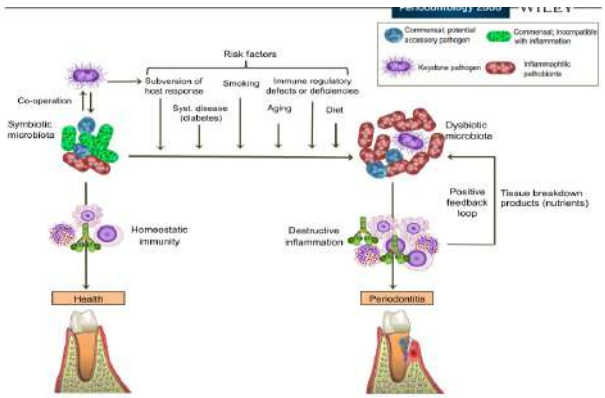

Figure 3 Polymicrobial synergy and dysbiosis model. (Adapted from Lamont Hajishengallis G. Polymicrobial synergy and dysbiosis in inflammatory disease. Trends Mol Med.)

composition of dental biofilms, ultimately leading to periodontal bone loss.[8] On this basis, P. gingivalis was labelled a "keystone" pathogen; this means that it is an organism that is central to the disease process, even when it is at a relatively low abundance species.

CONCEPT OF POLYMICROBIAL SYNERGY AND DYSBIOSIS

The keystone pathogen hypothesis has been extended to include the concepts of disrupted homeostasis in addition to the important roles of keystone pathogens in the "polymicrobial synergy" and "dysbiosis model" of disease.[9] The roles of other microbial communities such as commensal pathogen (accessory pathogen) and inflammophilic pathobiont were also considered.

Keystone pathogen

The term "keystone" has been introduced to characterize species whose effects on their communities are disproportionately large relative to their abundance and which are thought to form the "keystone" of the community's structure.[10] Although P. gingivalis is a low abundance species it causes periodontitis by dysbiosis (Figure 2).

Accessory pathogens whose pathogenic potential becomes evident only in the presence of a keystone pathogen. Keystone pathogens will alter immune surveillance and host defense which allows pathobiont to flourish in its community. Examples of pathobiont in periodontology are Filifactor alocis, Selenomonas, and Desulfobulbus.

Inflammophilic pathobionts refer to those microorganisms associated with periodontitis that may cause inflammation and use inflammatory conditions to prosper such as elevation in PH. An example of inter-bacterial dependency is the growth of Treponema denticola which is stimulated by isobutyric acid produced by P.gingivalis and T.denticola produces succinic acid, that supports the growth of P.gingivalis.[11]

IMPEDE MODEL - the most recent concept for periodontal disease pathogenesis

The most recent research on the oral microbiome has explored what triggers commensal microbes to alter the symbiotic state. The "inflammation-mediated-polymicrobial-emergence and dysbiotic-exacerbation" (IMPEDE) hypothesis suggests that the first stage of the process is the host's innate immune response to

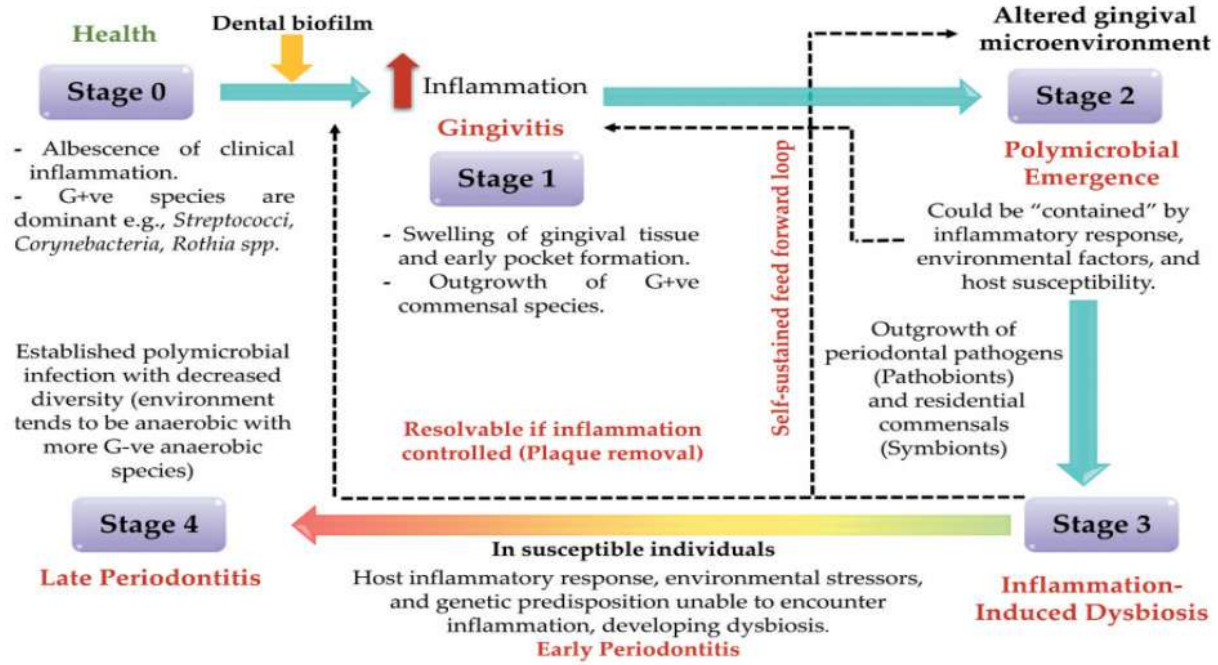

Figure 4. Inflammation-Mediated Polymicrobial Emergence and Dysbiotic Exacerbation (IMPEDE) model. (Adapted from Van Dyke TE, Bartold PM, Reynolds EC. The Nexus Between Periodontal Inflammation and Dysbiosis. Front Immunol. 2020; 11:511.)

maintain oral health or to restore symbiosis at the onset of gingivitis by producing initial inflammation. If this initial attempt by the host response is unsuccessful in restoring or maintaining a symbiotic or balanced state in the oral microbiome, then disease-producing microbes (pathobionts) tip the balance causing dysbiosis, ultimately leading to periodontitis.[12]

The IMPEDE model provides us with an overall understanding of how inflammation is a major driver of plaque-induced periodontitis. This model complements the 2017 classification of periodontitis.

Recognizes 5 stages (0 to 4)

0 Health

1 Gingivitis

2 Initiation (early periodontitis)

3 Inflammation-mediated exacerbation of dysbiosis by self-sustained feed forward loop

4 Late-stage periodontitis is characterized by a decrease in polymicrobial diversity associated with the emergence of a polymicrobial infection.

P4 PERIODONTICS AND "TREAT TO TARGET" MODEL FOR MANAGEMENT OF PERIODONTITIS

The term P4 medicine was coined by Dr. Leroy Hood[13] the basis of this concept is that medicine should move from a reactive to a proactive treatment approach, 4Ps stands for participation, prediction, prevention, and personalization. P4 medicine evolved to provide multilevel treatment management of chronic disease.[13] Since periodontitis is one of the most common chronic disease terms P4 periodontics[4] has been proposed. Incorporation of P4 medicine for the management of the disease requires knowledge of four fundamental aspects that are 1. disease severity 2. disease activity 3. disease control 4. Response to treatment. Now with the IMPEDE model, we understand how inflammation and periodontitis are related and resolution of inflammation bends the curve from inflammation-mediated tissue damage towards health trajectory.[14] The principle aim of this treatment is based on the medical model of "treat to target" and tries to shift the disease course from activity to remission and bend the curve toward health. The "treat to target" model for the management of periodontitis is consistent with the P4 periodontics model as it embraces disease personalization of individual's disease, path prediction of future disease, prevention of disease by changing the life course trajectory, and encourages participation by patient to understand the importance of their health.

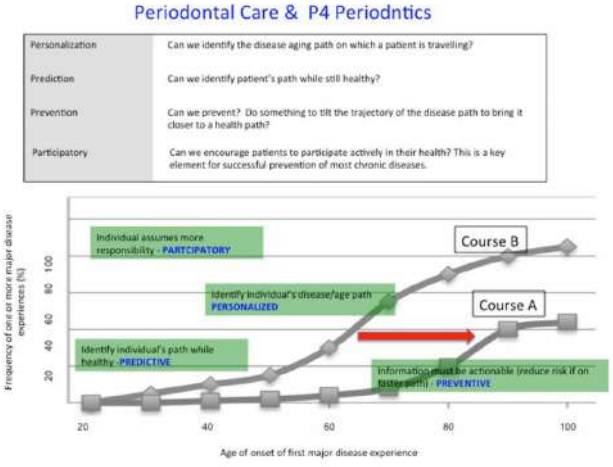

Figure 5. Periodontal care and P4 periodontics. Incorporation of the principles of P4 medicine into periodontics. (Adapted from Kornman KS, Giannobile W, Duf GW (2017) Quo vadis: what is the future of periodontics? How will we get there? Periodontol 2000 75:353–371.)

Ten principles for adopting "treat to target approach for management of periodontitis[14]

1 An initial target for the treatment of periodontitis should be a state of clinical remission that then allows reconstructive and regenerative procedures to follow if necessary.

2 Clinical remission will be defined as the absence/reduction of signs and symptoms of significant inflammatory disease activity that are responsible for the tissue damage associated with active periodontitis.

3 While remission should be a clear target, based on available evidence low disease activity may be an acceptable alternative therapeutic goal, particularly in long-standing refractory disease.

4 Until the desired treatment target is reached, therapies (mechanical, anti-inflammatory, and anti-infective) should be adjusted every 3–4 months.

5 Measures of disease activity must be obtained and documented regularly, as frequently as 3–4 monthly for patients with high/moderate disease activity, or less frequently (such as every 6–9 months for patients in sustained low disease activity or remission.

6 The use of validated composite measures of disease activity, which include periodontal assessments, is needed in routine clinical practice to guide treatment decisions.

7 Structural changes and functional impairment should be considered when making clinical decisions (i.e., predisposing factors).

8 The desired treatment target should be maintained throughout the remaining course of the disease.

9 The choice of the (composite) measure of disease activity and the level of target value will be influenced by consideration of co-morbidities, patient factors, drug-related risks, and microbiological profile.

10 The patient has to be appropriately informed about the treatment target and the strategy planned to reach this target under the supervision of the periodontist.

Conclusion

With this narrative review, we tried to explain the most recent concepts of periodontal disease pathogenesis. Periodontitis can no longer be considered a simple bacterial infection or a linear host response to microbial dysbiosis. It is characterized by a self-perpetuating state of prolonged inflammation, involving an interplay of a dysbiotic microbiome, a spectrum of host and environmental factors subsequently leading to tissue destruction. With recently developed models like IMPEDE and "treat to target" we concluded that inflammation is the main driver of the disease and resolution of inflammation can shift the trajectory of disease towards health. By adopting the concepts of P4 periodontics, plaque-associated periodontitis can be managed proactively to achieve the goal of healthy aging using a holistic management strategy. Prediction, prevention, personalization, and participation, these four pillars enable both periodontist and their patients to work together to encourage health and well-being throughout the life course of disease experience.

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Can Non-Surgical Periodontal Therapy Achieve Radiographic Bone Fill Around Teeth with Deep Angular Defects? - A Case Report

Anoop S[1]

ABSTRACT

Chronic periodontitis is an infectious disease leading to attachment loss and bone loss. Treatment modalities for this condition can be broadly classified into either surgical or non-surgical approaches. Extensive studies have been done to compare the clinical outcomes following surgical and non-surgical therapy and has concluded that both scaling and root planing (SRP) alone and SRP combined with flap surgery are effective methods for the treatment of chronic periodontitis but in the treatment of deep pockets (>6mm) open flap debridement results in greater probing pocket depth (PPD) reduction and clinical attachment gain. This case report illustrates a chronic periodontitis case in which radiographic bone fill and reduction in pocket depth was successfully achieved with SRP alone even around hopeless teeth (>10 mm PPD). Quadrant 1 and Quadrant 3 of the patient was managed by SRP combined with flap surgery; Quadrant 2 and Quadrant 4, by SRP only. Both treatment approaches had given comparable reduction in probing pocket depth and radiographic bone fill.

Keywords: Bone regeneration, Periodontitis, Periodontal regeneration, Non-surgical periodontal therapy, Periodontal surgery

Introduction

Chronic periodontitis has been defined as an infectious disease resulting in inflammation within the supporting tissues of the teeth, progressive attachment loss and bone loss.[1] According to the official guidelines of the American Academy of Periodontology, the goals of periodontal therapy are to preserve the natural dentition; to maintain and improve periodontal health, comfort, aesthetics, and function; and to provide replacements (i.e., dental implants) where indicated.[2] Several treatment modalities to achieve these goals are available and they can be broadly classified into either surgical or non-surgical approaches. Non-surgical therapy includes plaque control, supragingival and subgingival scaling, root planing, and the adjunctive use of chemotherapeutic agents. Surgical therapy can be divided into either resective or regenerative procedures. The presence of sites with a residual pocket depth ≥ 6mm after active treatment plays a significant role in predicting future periodontal destruction.[3] Thus, an important goal of periodontal therapy is to obtain a reduced pocket depth after treatment to prevent further disease progression. This goal can be accomplished by non-surgical therapy in patients with moderate periodontitis, whereas in severe cases, particularly in the presence of intrabony defects and furcation, the treatment must be supplemented with periodontal surgery. However, this case report illustrates a chronic periodontitis case in which radiographic bone fill and reduction in pocket depth was successfully achieved

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with scaling and root planing (SRP) alone even around hopeless teeth [>10 mm probing pocket depth (PPD)].

Clinical Presentation

A 47-year-old female patient presented to the department complaining of recurrent painful swelling on gums with associated bleeding while brushing. The patient had a non-contributory medical history. Her dental history included extraction of upper left back tooth due to pain and caries. No previous scaling or surgical debridement was attempted. On dental examination there was a deep proximal caries on tooth 47 and mesioangular impaction of tooth 48. Her oral hygiene status was poor with severe inflammation of gingiva. On periodontal examination there was deep periodontal pocket on teeth 16, 26, 35, 31(figure 1), 37, 41(figure 2),44 and 47 (figure 3). There was grade II mobility in relation to teeth 31,41 and 47, grade I mobility in relation to teeth 32 and 42. There was grade II furcation involvement of teeth 16, 37 and 47. Radiographically there was generalized loss of continuity of lamina dura with angular bone loss in relation to teeth 16,26,37,34,35,41,44,46 and 47. Tooth 47 shows a coronal radiolucency on distal aspect suggestive of caries. (figure 4)

Case Management

In the initial phase of periodontal therapy, a full mouth supragingival scaling followed by a deep subgingival scaling at two weeks interval using an ultrasonic device was carried out. Patient was given oral hygiene instructions and advised to use 0.2% chlorhexidine mouth rinse twice daily. Patient was advised, but not willing for extraction of impacted tooth 48. Two weeks after oral prophylaxis her gingival and periodontal status improved and she was placed on supportive periodontal therapy for three months. After three months patient was scheduled for surgical periodontal therapy. In the meantime, patient was advised to undergo endodontic treatment of teeth 41 and 47 and referred to department of conservative dentistry and endodontics.

Surgical periodontal therapy of Quadrant 1 and Quadrant 3 were done at one week interval. Adequate local anaesthesia was obtained using 2% lignocaine

Figure 1: Deep pocket of 8mm on 31

Figure 2: Deep pocket of >10mm on 41

Figure 3: Deep pocket of >10mm on 47

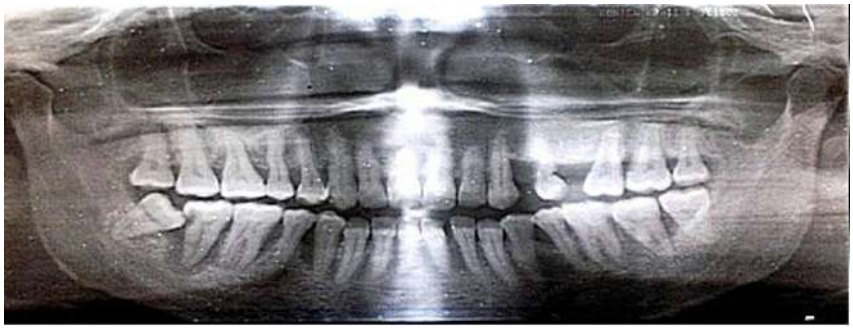

Figure 4: Pre-treatment orthopantomogram showing angular bone loss in relation to 16, 37, 34, 44, 46 and 47

Figure 5: Three walled defect on mesial aspect of 35 exposed after surgical debridement

with 1:200000 epinephrine. Modified Widman's flap was raised and the area thoroughly curetted with universal curettes. On surgical exposure a three-walled defect was noticed in relation to mesial aspect of tooth 35 (figure 5) and distal aspect of tooth 37 (figure 6) and a one walled defect on tooth 31 and the palatal aspect of tooth 16 (figure 7). Bioactive ceramic composite granules (50% Bioactive glass and 50% Hydroxyapatite mixture) were used as a bone graft in defects in relation to teeth 35 (figure 8) and 16 (figure 9). Synthetic nanohydroxyapatite granules were used in relation to tooth 37 (figure 10). Flaps were approximated and sutured using 3-0 braided silk suture using simple loop sutures in each papilla and a periodontal pack was placed. Postoperative medications included Amoxicillin 500mg thrice daily for five days and Ibuprofen 400mg thrice daily for two days. Patient was given postoperative instructions and was advised to continue mouth wash. Surgical therapy of Quadrant 2 and Quadrant 4 was not done since the patient was not willing for the same as her symptoms had subsided.

Clinical Outcomes

Healing after one week was uneventful and sutures were removed. Patient was placed on maintenance phase with regular recalls at one month, three month and six-month intervals after surgical therapy. Her gingival status was re-evaluated; oral hygiene instructions reinforced, and full mouth oral prophylaxis done at each appointment. PPD was measured at three month, six month and one year. Radiographic evaluation was also done at one year. Values of clinical parameters are shown in Table 1. Both surgical and non-surgical therapy had given a significant reduction in probing pocket depth (figure 11,12,13) and radiographic bone fill (figure 14). Mobility of the teeth reduced after one year, but there was grade II furcation involvement on tooth 47.

Discussion

Extensive studies have been done to compare the clinical outcomes following surgical and non-surgical periodontal therapy. Pihlstrom et al. published the

Figure 6: Three walled defect on distal aspect of 37 exposed after surgical debridement

Figure 7: One walled defect present on palatal aspect of 16 exposed after surgical debridement

Figure 8: Three walled defect on 35 filled with Bioactive ceramic composite granules

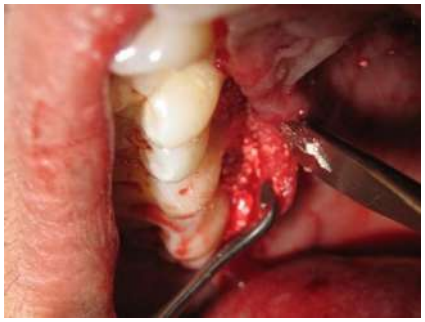

Figure 9: One walled defect on 16 filled with Bioactive ceramic composite granules

Figure 10: Three walled defect on 37 filled with synthetic nanohydroxyapatite granules

Figure 11: Pocket reduced to 3mm one year after non-surgical therapy on 41

results of a study comparing SRP and SRP followed by Modified Widman Flap (MWF) using a split mouth design. Their results showed that both methods were equally effective in pocket depth (PD) reduction in 4-6 mm sites.[4] Kaldahl et al. compared coronal scaling (CS), SRP, MWF, and Apically positioned Flap (APF) with osseous surgery (OS) in a split mouth design study.[5] The two-year results showed that the APF with OS group had the greatest PD reduction, followed by MWF, SRP, and CS. Lindhe et al. compared SRP, MWF, and Modified Kirkland Flap (KF) using a split mouth design and no differences were found in PD reduction or clinical attachment gain between the surgical and non-surgical methods. Granulation tissue removal was also shown as not being critical for proper healing conditions after flap surgery.[6] A systematic review concluded that both scaling and root planing alone and scaling and root planing combined with flap procedure are effective methods for the treatment of chronic periodontitis in terms of attachment level gain and reduction in gingival inflammation. The results of this case were in accordance with the previous studies. Both non-surgical and surgical therapy resulted in significant improvement in clinical parameters and periodontal status of the patient. Comparing PPD, gingival margin level and radiographs it can be concluded that this result may be a combined effect of recession, new bone formation and by formation of long junctional epithelium. The composition of bone graft was not found to be related with the amount of bone formation because 4mm of new bone has been formed with both grafts. According to Heitz-Mayfield (2002), for the treatment of deep pockets (>6mm), open flap debridement results in greater PPD reduction and clinical attachment gain.[7]

The significance of this case report is that 1) more than 5mm bone has been regenerated with SRP alone 2) teeth with hopeless prognosis (41,47) has been retained only with SRP and endodontic therapy although PPD of 7mm and grade II furcation involvement remained on tooth 47 after one year. Persisting PPD may be due to the involvement of furcation and due to the presence of impacted tooth 48 leading to plaque accumulation. Furcation areas present some of the greatest challenges to the success of periodontal therapy.[8] Reasons for compromised

Figure 12: Pocket reduced to 3mm one year after non-surgical therapy on 41

Figure 13: Pocket reduced to 3mm one year after surgical therapy on 31

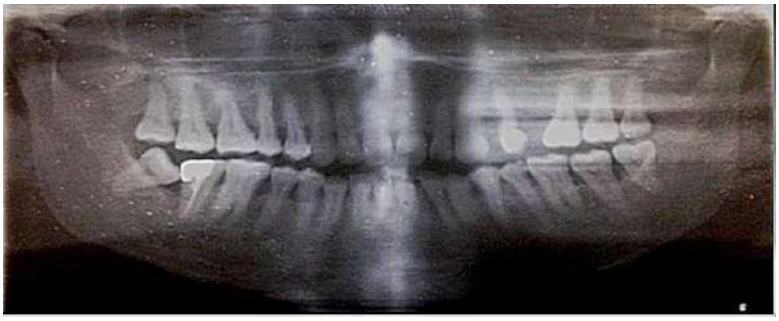

Figure 14: Post-treatment orthopantomogram showing appreciable bone fill in angular defects

results in furcation areas include lack of proper access for instrumentation due to furcation anatomy and, therefore, persistence of pathogenic microbial flora.[9] Decreased clinical response of furcation involved teeth to SRP has been reported.[10]

Caffesse et al. evaluated SRP efficacy with and without surgical access. Complete root cleaning was possible in 83% of the time in 1 to 3 mm pockets, 43% of the time in 4 to 6 mm pockets, and 32% of the time in ≥7 mm pockets. Surgical access improved calculus removal in the 4 to 6 and ≥7 mm pockets.[11] In this case SRP without surgical access was done on teeth with >10mm PPD which was not as per treatment guidelines. Hence, root instrumentation may not be complete with chances of residual calculus. Still the results were comparable to surgical therapy. Removal of granulation tissue from the defect may also be incomplete and the results justify the statement by Lindhe et al[6] that granulation tissue removal is not critical for proper healing conditions. These results somewhat questioned the significance of complete root debridement on arresting periodontal disease and justify Cobb's "critical mass" concept which states that a critical volume of calculus is needed for periodontal manifestations similar to that of plaque.[9] This may suggest a range of incomplete debridement

Table 1: Clinical Parameters

	baseline	1 month	3 months	6 months	1 year	1 ½ year
OHIS	4.6	0.3	1.5	1.5	2	1.8
GI	2.6	0.7	1.2	1	1.4	1.2
Surgical site (1st and 3rd quadrants)						
		Review after non-surgical therapy with SPT		Review after surgery with SPT		
Probing Pocket Depth in mm (deepest site)						
16	8	6	6	3	3	3
31	8	6	5	4	3	3
35	6	4	3	2	2	2
37	8	6	5	2	2	2
Gingival margin level from CEJ in mm						
16	0	1	2	3	3	3
31	1	2	3	4	4	4
35	0	1	2	2	2	2
37	0	1	1	2	2	2
Non-surgical site (2nd and 4th quadrants)						
		Review after non-surgical therapy with SPT				
Probing Pocket Depth in mm (deepest site)						
26	7	5	5	4	3	3
41	>10	8	6	4	3	3
44	>10	8	7	5	5	5
47	>10	9	9	8	7	7
Gingival margin level from CEJ in mm						
26	0	1	1	1	1	1
41	1	2	3	4	4	4
44	0	2	3	3	3	3
47	1	2	3	3	3	3

compatible with periodontal health.[12] The alteration of subgingival microflora caused by SRP may also explain the improvement in clinical parameters associated with SRP.[13]

Results of the longitudinal studies suggested that SRP were as effective as surgical procedures in arresting destructive periodontitis, and that thorough SRP was the critical determinant of success.[12] Interpretation of these results led to the development of "soft tissue management programs" for the treatment of periodontitis. Soft tissue management was defined as "the administration of non-surgical therapy to patients undergoing active treatment for some form of periodontal disease".[14] The procedure may consist of a combination of OHI, manual and/or mechanical SRP, delivery of local and/or systemic chemotherapeutic agents, and elimination of contributing factors. While SRP may resolve inflammation and arrest disease progression in some patients, in others it may not. It was also pointed out that before SRP is selected as the definitive mode of therapy, its limitations must be understood. Clinicians must critically appraise their ability to meticulously debride deep pockets and appreciate the skill level and time required for such treatment. Greenstein cited that "the length of therapy and the skill level of the therapist are critical determinants of successful SRP".[12]

Conclusion

Although a comparison of surgical and non-surgical periodontal therapies may provide an interesting academic discussion, the prudence of such a comparison is highly arguable. Reliance on empirical therapy for the treatment of a disease with multiple clinical presentations and a variety of contributing factors that are not always the same for all patients, such as the case with chronic periodontal disease, is not appropriate. Scaling and root planing, surgical resective and/or regenerative procedures, and antibiotic therapy are available therapeutic modalities that should be used in different combinations for individual patients and/or sites as needed to achieve the ultimate goal of therapy.

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Pedicle Grafts In Gingival Recession Management: A Comprehensive Overview

Sandra Rachel Cheriyan[1], Sanjeev Ravindran[2], Shyamala Devi M.P[3]

ABSTRACT

As gingival recession increasingly impacts individuals, achieving root coverage has become integral to aesthetic and periodontal treatments. Gingival recession, characterized by the apical migration of the gingival margin beyond the cementoenamel junction (CEJ), necessitates root coverage procedures for addressing aesthetic concerns, hypersensitivity, gingival margin inconsistencies, and augmentation of keratinized tissue. Various approaches, including restorative, orthodontic, and surgical modalities, have been developed to treat single or multiple defects associated with gingival recession.

This review focuses on surgical root coverage techniques, particularly highlighting the efficacy of pedicle grafts such as the lateral repositioned flap, double papilla flap, semilunar flap, and coronally advanced flap. The pedicle graft involves strategically repositioning donor tissue from adjacent areas to the recession defect, eliminating the need for a secondary surgical site. An inherent advantage of the pedicle graft lies in its maintained blood supply from the base of the flap, fostering graft nourishment and promoting vascular union with the recipient site. This review underscores the importance of obtaining optimal outcomes through the least traumatic, comfortable, and patient-preferred methods for root coverage procedures. By providing insights into the advantages and considerations associated with pedicle grafts, this review aims to guide clinicians in selecting the most effective strategies for addressing gingival recession while optimizing patient experience and clinical outcomes.

Keywords: Gingival recession, Root coverage, Pedicle graft

Introduction

In contemporary dentistry, the emphasis on meeting patients aesthetic expectations has propelled root coverage for gingival recession into a pivotal role within the realms of aesthetics and Periodontology. Gingival recession, characterized by the apical displacement of the gingival margin, is influenced by various risk factors, including attachment loss associated with periodontal disease, buccally placed teeth, high frenal attachment, mechanical trauma, thin biotype, lack of attached gingiva, and the presence of bone deficiencies. Of these, inflammatory periodontal conditions and mechanical trauma stand out as primary contributors.[3]

Although gingival recession is a prevalent concern across diverse global populations, it is notably more common among the elderly. The aging process increases the likelihood of gingival recession, rendering it age-associated rather than age-related.[3] Efforts to achieve successful coverage of exposed roots, driven by both aesthetic and functional considerations, have been the focal point of various periodontal surgeries.[4]

Periodontal plastic surgery is defined as a "surgical procedure performed to correct or eliminate

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anatomical developmental, or traumatic deformities of the gingival or alveolar mucosa".[4] Among various periodontal plastic surgeries, surgical procedures used in the treatment of recession defects may basically be classified as follows : [4]

Pedicle soft-tissue graft procedures	● Rotational flap procedures (laterally sliding flap, double papilla flap, oblique rotated flap) ● Advanced flap procedures (coronally repositioned flap, semilunar coronally repositioned flap) ● Regenerative procedures (with barrier membrane or application of enamel matrix proteins)
Free soft-tissue graft procedures	● Epithelialized graft ● Subepithelial connective tissue graft

The purpose of developing new techniques is to increase predictability and reduce patient discomfort and the number of surgical sites, along with the need to satisfy the patients aesthetic demands, which include the final colour and tissue blend of the grafted area. Several graft procedures are used to obtain coverage, but they have not been able to deliver predictable and satisfactory results, except for connective tissue grafts.[6] Some of these procedures also resulted in a secondary surgical site that was very uncomfortable for the patients. Hence, there was an intense need for a graft that has its blood supply, which can be harvested adjacent to the recession defect in sufficient amounts without requiring any second surgical site and has the potential for promoting the regeneration of lost periodontal tissue.

The adult human periosteum is highly vascular and known to contain fibroblasts, osteoblasts, and their progenitor cells (i.e., stem cells). In all age groups, the cells of the periosteum retain the ability to differentiate into fibroblasts, osteoblasts, chondrocytes, adipocytes, and skeletal myocytes. The tissues produced by these cells include cementum with periodontal ligament fibres and bone. Additionally, the presence of periosteum adjacent to gingival recession defects occurring in sufficient amounts makes it a suitable graft.

Mahajan has described a new procedure for recession coverage by utilizing the periosteal pedicle graft. This graft utilizes the osteogenic potential of the periosteum, which is due to its highly vascular nature, presence of fibroblasts, osteoblasts, and stem cells.[6]

A pedicle graft involves repositioning donor tissue from an area adjacent to the recession defect to cover the exposed root surface. It avoids the need for a second surgical site and has the advantage of retaining its blood supply from the base of the flap, which remains attached to the donor site. This helps nourish the graft and facilitates vascular union with the recipient site.

History

Introduced in 1957 by Friedman, mucogingival surgery initially encompassed procedures focused on preserving gingival tissue, eliminating aberrant frenal or muscle attachments, and augmenting vestibular depth. Over time, however, the term became synonymous with pocket elimination approaches. Recognizing this semantic ambiguity, Miller, in 1993, proposed the term "periodontal plastic surgery".

The pedicle graft technique, a notable advancement in addressing root coverage, was introduced in 1956 by Grupe and Warren. Their innovative approach involved elevating a full-thickness flap one tooth away from the defect and rotating it to effectively cover the recession. Subsequent developments in the field include Hattler's use of a sliding partial-thickness flap to rectify mucogingival defects on two or three adjacent teeth. In 1968, Cohen and Ross introduced the double-papilla repositioned flap, leveraging interproximal papillae to cover recessions and correct gingival defects in areas lacking sufficient gingiva, which are unsuitable for a lateral sliding flap.[5] These progressive techniques have significantly contributed to the evolution of periodontal plastic surgery, offering diverse solutions for optimal root coverage and aesthetic enhancement.

INDICATIONS OF PEDICLE GRAFT[2]

- Inadequate amount of attached gingiva
- Single or multiple adjacent recessions that have adequate donor tissue laterally (root coverage)
- Recession next to an edentulous area

- Sufficient tissue present adjacent to area of recession
- Suitable for recession with narrow mesiodistal width

CONTRAINDICATIONS OF PEDICLE GRAFT[2]

- Insufficient keratinized tissue at the donor site
- Presence of deep interproximal pockets
- Excessive root prominences
- Deep or extensive root abrasion or erosion
- Significant loss of interproximal bone height
- Narrow vestibule
- Multiple tooth involvement

ADVANTAGES OF PEDICLE GRAFTS[2]

- One surgical site
- Good vascularity of the pedicle flap
- Ability to cover the denuded root surface

DISADVANTAGES OF PEDICLE GRAFT[2]

- Limited by the amount of adjacent keratinized attached gingiva
- Possibility of recession at the donor site
- Dehiscence or fenestrations at the donor site
- Limited to one or two teeth with recession

LATERALLY POSITIONED FLAPS

In 1956 Grupe and Warren developed an original and unique procedure called the sliding flap operation for covering the isolated exposed root.[7] Later in 1966 they modified the technique to prevent the donor site recession. In this procedure, the adjacent keratinized gingiva is positioned laterally, and the exposed root surface in the localized gingival recession is covered with good vascularity and only one surgical site is needed. The disadvantages of this method are possible bone loss and gingival recession on the donor site. Guinard and Caffesse reported an average of one millimetre of postoperative gingival recession on the adjacent donor site.[8]

Laterally positioned flaps are indicated when there are sufficient dimensions of keratinized tissue adjacent to the area of gingival recession, and coverage is limited to one or two teeth. This technique is most suitable for root coverage in narrow types of gingival recession, such as those found in the mandibular anterior area.[5] However, it is contraindicated in cases of insufficient keratinized tissue at the adjacent donor site, extremely thin bone or osseous defects at the donor site, deep pockets with the loss of interdental alveolar bone in the adjacent area, shallow vestibules, extremely protrusive gingival recession areas, excessive root prominences, deep or extensive root abrasion or erosion, significant loss of interproximal bone height, and multiple tooth involvement.

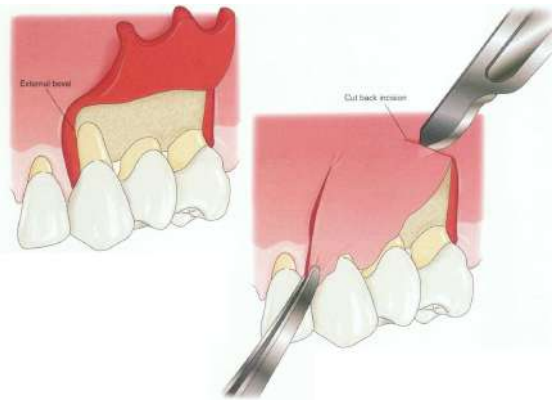

Figure1-a. Prepare a full-thickness pedicle flap and If the flap is strained after displacement to the recipient site b. make a releasing incision of the periosteum or cut back the incision at the base of the flap.[2]

Figure 2 a. Suture the pedicle flap on the mesial interdental papilla area of the recipient site b. Completion of suture. Make a periosteal suture on the mesial aspect[2]

SURGICAL PROCEDURE

Pedicle flap design

Make a V-shaped incision in the peripheral gingiva in the gingival recession area while preserving sufficient interdental papilla on the distal aspect. A wide external bevel incision on the mesial aspect and an internal bevel incision on the distal aspect create close adaptation of the flap. Remove the V-shaped gingiva and make a bevel for flap adaptation. Make an internal bevel incision toward the alveolar bone crest from the free gingival margin of the donor site. Prepare a vertical incision one and one-half teeth from the recipient site. Prepare a full-thickness pedicle flap. If the flap is strained after displacement to the recipient site, make a releasing incision of the periosteum or cut back the incision at the base of the flap. (Figure 1 a and b) Cover the exposed root surface completely with the pedicle flap and suture the flap coronal to the CEJ. To minimize postoperative gingival recession at the donor site, place a free autogenous gingival graft.[2]

TRANSPOSITIONAL FLAPS

Bahat et al modified the oblique rotated flap introduced by Pennel et al[2] (Figure 2 a and b). This is called the transpositional flap. The advantages of this procedure are predictability in areas of narrow root exposure, possible to avoid gingival recession at the donor site and disadvantages include, sufficient length and width of the interdental papilla adjacent to the gingival recession area necessary, not suitable for multiple tooth root coverage[14]

DOUBLE PAPILLA FLAPS

Cohen and Ross introduced a method utilizing bilateral interdental papilla as donor tissue for localized root coverage, reducing the risk of flap necrosis and simplifying suturing due to the thicker and wider nature of interdental papilla compared to labial gingiva on the root surface. This technique is known as double papilla flaps. Indications for its use include sufficient width and length of the interdental papilla on both sides of the gingival recession area. Noteworthy advantages include the minimal donor tissue required, as the displaced interdental papilla adjacent to the recession area reduces tension on the pedicle flap. Additionally, using this method causes little damage to the alveolar bone, as the interdental alveolar bone is thick. This approach also minimizes the risk of alveolar bone loss, given the greater resistance of interdental bone compared to radicular bone.[2]

The papillae usually have thicker gingiva with greater width of attached gingiva as compared to the radicular surface of teeth, the clinical predictability of this procedure is fairly good. The primary disadvantage of this procedure is that it is a technique sensitive procedure where two interdental papillae are joined together to act as a single flap, limited application. The technique is generally used for multiple interdental papilla grafting, not for root coverage. The objective is to increase the width of the attached gingiva

SURGICAL PROCEDURE

1. Make a V shaped incision with a bevel on the mesial interdental papilla surface

2. Remove the v shaped tissue.

3. The flap design includes a horizontal incision to the mesiodistal interdental papilla on the coronal side and two vertical incisions.

4. Prepare a full thickness pedicle flap including

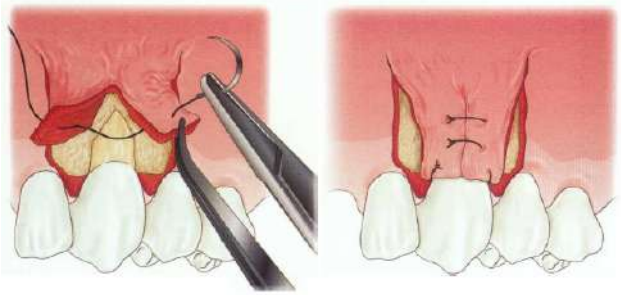

Figure 3 a-Suture each flap and make a double papilla flap b.Cover the exposed root with the double papilla flap. Stabilize the flap coronal to the CEJ with a sling suture.[2]

Figure 4 schematic representation of oblique incision[18]

a sufficient interdental papilla on the mesial and distal sides.

5. Make a partial thickness flap on the apical part of the flap for easy flap migration.

6. Reflect flaps

7. Suture each flap and make a double papilla. (Figure 3a)

8. Cover the exposed root with the double papilla flap. Stabilize the flap coronal to the CEJ with a sling suture. (Figure 3b)

The double papilla procedure is technique sensitive but has good results in treating isolated recessions. The partial thickness double papilla pedicle graft technique was first proposed by Cohen and Ross. Hall stated that double pedicle graft had "very low predictability in most practitioners hands".[2] The 1989 World Workshop in clinical Periodontics concluded "the double papilla pedicle has very limited usefulness." Its weaknesses are its poor predictability and the technical skills required to perform the procedure. Nelson proposed a technique that combines a free connective tissue graft with a full thickness double papilla graft.[15] Harris further proposed the use of a partial thickness double pedicle flap rather than a full thickness one overlying a free connective tissue graft as partial thickness flap allows the connective tissue graft to receive vascular supply both from the recipient bed and from the flap overlying it.[16]

CORONALLY ADVANCED FLAP

The coronally advanced flap (CAF) is the gold standard technique in case of adequate presence of keratinized tissue apical to the defect. In circumstances where this does not apply due to unfavourable anatomic conditions as for example: very shallow vestibule, absence of keratinized tissue apical to the defect, presence of gingival cleft, marginal insertion of frenuli; the performance of a laterally positioned flap should be taken into consideration.

The coronally advanced flap procedure is a very common approach for root coverage. This procedure is based on the coronal shift of the soft tissues on the exposed root surface. It is the technique of choice for the treatment of isolated gingival recession. It is technically simple, well tolerated by the patient [because the surgical area is limited and does not require removal of tissue far from the tooth with the gingival recession (palate) and provides optimal results from an esthetic point of view. The conditions required to perform the coronally advanced flap are the presence of keratinized tissue, apical to the root exposure, of an adequate height (1 mm for shallow recessions and 2 mm for recessions ≥5 mm) and thickness. The technique was initially described by Norberg and subsequently reported by Allen & Miller[11]. Recently, it was modified using a trapezoidal flap design and a split–full–split-thickness flap elevation approach.

A recent systematic review concluded that the coronally advanced flap procedure is a safe and predictable root coverage surgical procedure for the treatment of single type gingival recessions.[12] The mean percentage and the percentage of complete root coverage of the articles comprised in the systematic review. The modified coronally advanced flap technique presented some clinical and biologic advantages over the split–full–split-thickness flap elevation: the split-thickness elevation at the level of the wide (3 mm) surgical papilla provided anchorage and blood supply to the interproximal areas mesial and distal to the root exposure. Furthermore, the partial thickness of the surgical papillae facilitated the nutritional exchanges between them and the underlying de-epithelialized anatomical papillae and improved the blending (in terms of color and thickness) of the surgically treated area with respect to the adjacent soft tissues. The full-thickness elevation of the soft tissue apical to the root exposure conferred more thickness and some periosteum, and thus better opportunity to achieve root coverage to that portion of the flap residing over the exposed avascular root surface. The more apical split-thickness flap elevation facilitated the coronal displacement of the flap. Although the technique included vertical releasing incisions, these did not result in unesthetic scars. In fact, these incisions were beveled in such a way that the bone and periosteal tissues were not included in the superficial cut and thus did not participate in the healing process. Another important modification of the present surgical technique, with respect to the previously proposed techniques[17], was that the coronal advancement of the flap was not obtained by periosteal incisions, but rather by cutting the muscle insertions included in the thickness of the flap.

SEMINULAR CORONALLY ADVANCED FLAP AND ITS MODIFICATIONS-TARNOW TECHNIQUE[13]

This technique was first described by Kamran Haghighat in 2006. Semilunar incision following the curvature of the free gingival margin was made. The incision was curved apically far enough mid-facially to ensure that the apical part of the flap rests on bone after it was brought down to cover the exposed root. The incision ended into the papilla on each end of the tooth, but not all the way to the tip of the papilla. At least 2 mm was left on either side of the flap, since this is the main area from which the blood supply will be attained. Using a number 15 blade, a split thickness dissection was made from the initial incision line coronally. This was connected with an intrasulcular incision, made mid-facially The mid-facial tissue was then coronally positioned to the CEJ, or to the height of the adjacent papilla in cases of interproximal recession. The tissue was held in place with moist gauze against the tooth for 5 minutes. The area was covered with periodontal pack (CoePack)The patient was placed on a soft diet for a period of 10 days.

MODIFICATION OF CORONALLY ADVANCED FLAP-ZUCCHELLI'S TECHNIQUE[11]

Coronally advanced flap is always the first choice in patients with the recession defect having a residual amount of keratinized tissue apically.[17] In 2000, Zucchelli and de Sanctis modified coronally advanced flap procedure to treat teeth with multiple recession defects. Sufficient root coverage and colour matching with adjacent soft tissue are the outcome measures to be considered for successful surgical procedures. Complete recovery with the marginal morphology of pre surgical soft tissue is also the criterion for the measurement of successful surgery. Furthermore, less discomfort is experienced during the postoperative period as other treatment areas distant from the tooth with recession site are not involved. The split–full-split approach was used to elevate the envelope flap. (Figure 4) The superficial incision was used to achieve the coronal advancement of the envelope flap. The incision eliminated lip muscle insertion occupying the thickness of the flap.[11]

Zucchelli's coronally advanced flap does not consist of vertical releasing incisions. The flap contains variable thickness with the split–full-split approach. Another feature of Zucchelli's technique is the submarginal oblique incisions in the interdental area connecting the cementoenamel junction of one tooth to the marginal gingiva of the adjacent tooth.In this case report, Zucchelli's coronally advanced flap with envelope technique is used to treat multiple Miller's Class I recession defects in the patient.[11]

HEALING OF PEDICLE SOFT TISSUE GRAFTS

Healing in the area where the pedicle graft is in contact with the denuded root surface was studied by Wilderman & Wentz in1965.

The adaptation stage (from 0 to 4 days)

The laterally repositioned flap is separated from the exposed root surface by a thin fibrin layer. The epithelium proliferates and reaches contact with the tooth surface at coronal edge of flap after few days.

The Proliferation (4-21 days)

After 6-10 days a layer of fibroblasts is seen in opposition to the root surface. At the end of the proliferation stage, thin collagen fibers are formed adjacent to the root surface, but a fibrous union between the connective tissue and the root has not been observed.

From the coronal edge of the wound, epithelium is proliferating epically along the root surface, According to Wilderman & Wentz in 1965, the apical proliferation of epithelium may stop within the coronal half of the direct, although further down growth of epithelium was also frequently observed

The attachment stage (from 21 to 28 days)

During this stage of healing thin collagen fibers become inserted in a layer of new cementum formed at the root surface in the apical portion of the recession.

The maturation stage

This last stage of healing is characterized by continuous formation of collagen fibers. After 2-3 months, bundles of collagen fibers are inserting into the cementum layer on the curetted root surface in the apical potion of the recession.

Conclusion

The management of gingival recession demands a nuanced approach, especially when considering the use of connective tissue grafts. While clinical methods offer a pragmatic means of determining root coverage levels, the gold standard remains the bilaminar technique, featuring a coronally advanced flap with a connective tissue graft. This approach significantly enhances the likelihood of achieving complete and predictable root coverage, especially in long-term follow-up, albeit primarily for single-type defects.

However, the application of connective tissue grafts becomes more intricate when addressing multiple gingival recessions due to limitations in tissue availability, increased patient morbidity, and the heightened risk of dehiscence. The disparities in colour, texture, and surface characteristics between grafted and adjacent tissues pose challenges, particularly for patients with aesthetic demands. Clarification through detailed studies is essential to identify the specific gingival recessions that warrant the adjunctive use of connective tissue grafts in multiple recession cases.

Recent advances in pedicle graft techniques, encompassing variations like the coronally advanced flap (CAF) double papilla flap, rotational flaps, Zucchelli's technique and Tarnow's technique showcase the evolving landscape of periodontal therapies. These diverse pedicle graft approaches not only enhance root coverage predictability but also address complexities associated with multiple gingival recessions.

Looking forward, ongoing research and clinical trials are imperative to refine protocols, explore new applications, and ascertain the optimal use of various pedicle graft types. The quest for suitable substitutes for connective tissue grafts, with a keen focus on patient-centered outcomes, is expected to shape the future of periodontal interventions. The dynamic field of periodontics continues to evolve, emphasizing the importance of adapting techniques to meet the diverse challenges presented by gingival recession.

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