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The big names in Periodontics in one frame, taken during the alumni CDE "PERIOCOM 2019" of Department of Periodontics GDC Trivandrum

From left: **Dr Kunjamma Sebastian, Dr Presanthila Janam, Dr Rezy Cheru T., Dr Thomas C. Thelly, Dr Meherunnisa Bai and Dr Nandakumar K**

Picture Courtesy: Dr Baiju RM, Additional Professor, Govt. Dental College, Kottayam

SOCIETY OF PERIODONTISTS AND IMPLANTOLOGISTS OF KERALA

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President's message

Dear colleagues

Warm regards to you all.

At this time of unprecedented disruption, caused by the Covid -19 pandemic all of us are adapting to support ourselves.

Practicing dentistry during this troubled times is extremely demanding. At present during lockdown, dentists are allowed only to perform basic dental treatments, without generating aerosols. Any sophisticated treatments tend to generate some amount of aerosol so most of the dentists stopped working altogether.

As a speciality periodontists are more affected since our procedures are elective and may be very well postponed.

Post lockdown scenario is also bleak, even with proper screening and careful case selection you might come across a covid-19 positive case in your operatory. It's not practical or financially viable to wear a complete, fool proof PPE suite in many clinics for the day to day practice especially for minor procedures.

Recently the central government came out with a notification where they categorized ENT surgeons, Ophthalmologists & Dental surgeons in the same risk group. They suggested using N95 Masks, Face-shields & routine protective gears like gloves and long sleeved aprons / uniforms and NOT the PPE suites, (which they use in the critical care units where the corona patients are admitted). In that notification it's clearly mentioned that minimal aerosol production is anticipated during the procedures.

So legally we are protected to work without PPE suites and to generate minimum amount of aerosols, but personally I feel we will have to wait months to reach a stage where we can practice with confidence.

To reach that stage there should be a cure or a vaccine for this dreaded Covid -19 virus, available at a reasonable expense. Mean while a fast, sensitive and affordable test might help us to a certain extent. If so, just like we send for routine blood picture we should be able to screen all the patients with that test.

Friends "after every storm there will be a rainbow" let us hope that we will overcome this storm to enjoy the rainbow.

Thank you

Dr Sabu Kurian

Guest Editorial

Dr MEHERUNISSA BAI

- Completed graduation (1969) and post graduation (1978) from GDC, Thiruvananthapuram.
- Joined department of Periodontics as Tutor in 1971
- Worked as Professor & HOD at GDC Thiruvananthapuram and Kozhikode.
- Chairman Pass Board and member of PG Board of studies
- Retired from Govt. service in 1998.
- Former HOD – Department of Periodontics, Bangalore Institute of Dental Sciences (BIDS), Bangalore and NIMS, Balaramapuram.
- Former Principal Royal Dental College, Chalichery, Thrissur.
- Owns Residential dental practice at Sreekariyam, Thiruvananthapuram

JUVENILE PERIODONTITIS AND MANAGEMENT

The principal cause of periodontal disease which effect the periodontal tissue is the bacterial plaque. However, a wide range of background factors such as age, sex, education, place or residence, oral hygiene habits, social economic status, genetic characteristics, smoking habits etc have been identified as risk factors for the occurrence of periodontal disease.

Apart from this juvenile periodontitis(JP) is a rare condition occurring in young adults, characterised by early loos of teeth in healthy individuals. The early feature noticed by the patient may be diastema occurring in the upper anterior, with mobility of anteriors and first molars due to bone loss. The radiographs reveal angular type of bone loss around both anteriors and posteriors. Usually gram - negative anaerobic bacteria is associated with the pathogenicity of all periodontal diseases. And in this case, bacterial invasion may be secondary, and the primary factor is attributed to degenerative changes.

A long time therapy with tetracyclines and doxycycline is found effective in the treatment of JP and its progression. The prime factor is to maintain good oral hygiene by effective scaling, root planning and if required surgical intervention. Bone grafting may be required in some cases to restore the lost apparatus. The first and foremost line of treatment is oral health education to the public to maintain good oral condition.

Secretary's Message

Dear SPIK Members

Another memorable SPIK year has passed by with a most befitting conclusion on January 4 and 5 at the Annual Conference. SPIK was fortunate to be led during this period by Dr Harikumar Menon, the President, ably supported by a dedicated team of Office Bearers. His efforts are sincerely appreciated and acknowledged with gratitude. I also take this opportunity to congratulate Dr Jose Paul and his team at Annoor Dental College, Muvattupuzha for organizing the Annual Conference in the best possible manner, making it one of the most participated SPIK events to date.

Moving forward, SPIK has entered another year under the leadership of Dr Sabu Kurian, our new President. A proud Periodontist, a person with nearly three decades of specialty practice and a proven leader in dental fraternity, I am sure Dr Sabu will be able to further the cause of SPIK and Periodontics at large. He has his vision focused on improving periodontal practice in general dentistry and the events of this year are being planned accordingly.

Let me congratulate our editor, Dr Sameera for her perseverance and dedication in continuing with this demanding job and bringing out our journal on time. I request all members to make use of this opportunity for publishing their work

Sometimes, even the best laid plans go awry due to no fault of ours. We are witnessing the same in 2020, where the entire mankind has been afflicted by the COVID-19 scare. Let's all use this as an opportunity to look back and reflect upon ourselves. Hope all of you are keeping safe wherever you are and spending quality time with your near and dear ones. SPIK salutes all our members who are still involved in their official commitments or voluntary activities as part of the fight against corona virus. We sincerely hope and pray that this period of uncertainty gets over soon and the world resumes its routine at the earliest.

"If you want the rainbow, you gotta put up with the rain" (Dolly Parton)

The best days are waiting

Regards

Dr. Jayan Jacob Mathew
Secretary, SPIK

JSPIK

Thickness of Palatal Masticatory Mucosa in subjects with different Periodontal Phenotypes

Anu Chandran[1], Rahul Bhandary[2], Nina Shenoy[3], Amitha Ramesh[4], Biju Thomas[5]

ABSTRACT

Background: The palatal masticatory mucosa (PMM) is considered to be the main donor area of soft tissue grafts in periodontal plastic surgery for procedures such as root coverage, increasing the width of the attached gingiva, in alveolar ridge augmentation and for vestibuloplasty to increase the supportive area of the denture base. The thickness of graft tissue is an important factor for graft survival. An accurate diagnosis of gingival phenotypes, both facial and palatal, is of paramount importance in devising an appropriate treatment plan and achieving a predictable aesthetic and functional outcome.

Aim: The purpose of this study was to clinically evaluate the thickness of PMM in association with the gingival phenotype in non-periodontitis patients by bone sounding.

Materials & methods: Sixty-five periodontally healthy dentate subjects with gingival recessions were enrolled in the study. After initial periodontal therapy, they were scheduled for surgical procedures. The thickness of the PMM of four teeth was evaluated at three different levels from the gingival margin on the palate, and thickness of the buccal gingival mucosa was evaluated mid-buccally in the attached gingiva of maxillary anterior region, on the day of surgical intervention via the bone sounding method.

Conclusion: Canine and premolar regions reveal higher thickness values, while thinnest in the first molar region and the increase in the tissue thickness towards the midline should also be taken into consideration. Canine and premolar areas appear to be the most appropriate donor site for grafting procedures. The palatal mucosal thickness adjacent to the palatal root of 1st molar provided limited donor tissue volume for graft harvesting.

Keywords: Palatal masticatory mucosa, Gingival phenotype, Bone sounding.

Introduction

Masticatory mucosa is a keratinized stratified squamous epithelium lining the dorsum of the tongue, hard palate, and gingiva.[1] The palatal masticatory mucosa - PMM is considered to be the principal donor area of soft tissue grafts in periodontal plastic surgery for root coverage procedures, increasing the width of the attached gingiva, and for alveolar ridge augmentation.[2]

The volume and characteristics of tissue that can be obtained from this area are important in determining appropriate treatment modality and predicting the prognosis. Revascularization of the graft may be prevented, if the donor tissue is too thick, and graft shrinkage may occur if the tissue is too thin.[1] Hence thickness of graft tissue is a principal factor for graft survival. There are invasive and non-invasive methods of mucosal thickness evaluation.

[1]Post Graduate Student, [2-5]Professor, Department of Periodontics, AB Shetty Memorial Institute of Dental Sciences Deralakatte, Mangalore - 575 018. Corresponding Author: Prof (Dr.) Rahul Bhandary, Email: bhandaryrahul@gmail.com

"Bone sounding" is a direct measurement method that provides the most reliable results regarding the thickness of the PMM. Intra-individual and inter-individual variations in the thickness of PMM have been reported.[1]

Gingival phenotype/biotype is described as the thickness of the gingiva in the facio-palatal / facio-lingual dimension. Periodontal phenotype is considered to be thin- scalloped or thick-flat. Thick gingival phenotype usually depicts a broad zone of keratinized tissue with a flat gingival contour which indicates thick underlying bony architecture and is more resilient to any inflammation or trauma. On the other side, the thin gingival phenotype depicts a thin band of the keratinized tissue and scalloped gingival contour which suggests thin bony architecture and is more sensitive to any inflammation or trauma. Inflammation of the periodontium results in increased pocket formation in thick phenotype and gingival recession in thin tissues.[3]

Gingival thickness plays an important role in wound healing and flap management during regenerative surgical procedures. To predict postoperative outcomes, an accurate preoperative diagnosis of the dimensions of the periodontium becomes necessary. Distinct characteristics of facial gingiva might also be mirrored in the palatal mucosa.[4] Therefore, an accurate diagnosis of gingival phenotype, both facial and palatal, is of utmost importance in devising an appropriate treatment plan and achieving a predictable aesthetic and functional outcome.

Therefore, the primary goal of the present study was to determine the thickness of palatal masticatory mucosa as well as assessing the association between gingival thickness and PMM in non-periodontitis patients by bone sounding.

Material and Methods

Sixty-five healthy non-periodontitis patients of Dakshina Kannada region (30 males and 35 females) with age group 18-40 years with complete maxillary dentition, referred to Department of Periodontics with the chief complaint of the gingival recession were enrolled into this study. The subjects had healthy gingiva with no evidence of bleeding on probing, suppuration or any other clinical signs of inflammation. Informed consent was obtained from all individuals prior to the procedure.

The exclusion criteria were previous surgical intervention of the affected area, history or presence of pathology at PMM and facial gingiva, implants, periodontal disease, orthodontic retainers and prosthetic appliances at the site of evaluation, tooth malalignment, use of any medication possibly affecting the periodontal tissues, smokers, pregnant and lactating females, and any systemic disease that can affect the mucosal structure in the oral cavity.

After initial periodontal therapy, they were scheduled for surgical procedures. The following assessment was done, on the day of surgical intervention via the bone sounding method.

A. The thickness of the Palatal masticatory mucosa (PMM) of four teeth was evaluated on the hard palate

B. The thickness of the buccal gingival mucosa was evaluated in the attached gingiva of the maxillary anterior region.

Palatal masticatory mucosa thickness assessment:

After administration of local anaesthesia, PMM thickness was assessed at 12 assessment points on the palate in relation to canines (C), premolars (P1, P2) and molar (M1) at 3 different levels in the palate -3, 5 and 7mm respectively from the gingival margin, starting at the mid –palatal aspect of the canine and ending over the palatal root of the first molar.

The four points (C, P1, P2, M1) were defined on each of the 3 lines, constituting four positions, each located at the level of a tooth, designated for assessing the palatal mucosa thickness in the hard palate by bone sounding. The distances between these reference points were determined with William's periodontal probe and marked on the palate by an eosin pencil (Figure I). Palatal masticatory mucosa thickness was then assessed at 12 assessment points on the hard

palate by bone sounding using a sterile endodontic spreader (#20) fitted with a silicone stop (Figure II). The extent of penetration was measured by using a ruler as well as Vernier calliper and the recordings were rounded off to the nearest millimeter.

Gingival phenotype assessment:

Facial gingival thickness was assessed mid-buccally in the attached gingiva, halfway between the mucogingival junction and free gingival groove in the maxillary anterior region by bone sounding using an endodontic spreader fitted with the rubber stopper inserted perpendicularly into the gingival surface (Figure III). The distance between the rubber stopper and the tip of the spreader was measured on the scale. The measurement value of ≤1 mm was considered as thin gingiva and >1 mm was considered as thick gingiva.[5,6]

The endodontic spreader with silicone stopper securely in place was then lined up to a 0.5mm sterile, stainless steel ruler and the value was consistently rounded up to the nearest 0.5mm, for definite reading Vernier calliper was also used.

Statistical Analysis

Data were analyzed using an unpaired t-test to compare gender, gingival thickness group for C, P1, P2, and M1. Karl Pearson correlation was used to correlate

TABLE 1: Mean thickness of palatal masticatory mucosa between thin and thick gingiva

G thickness grp		N	Mean	Std. Deviation	t	P
C-3mm	Thin	49	1.078	.1104	-9.241	0.001
	Thick	16	1.819	.3146		sig
C-5mm	Thin	49	1.555	.5066	-5.323	0.001
	Thick	16	2.244	.4289		sig
C-7mm	Thin	49	2.318	.6894	-3.215	0.003
	Thick	16	2.819	.4820		sig
p1-3mm	Thin	49	1.116	.1962	-5.426	0.001
	Thick	16	1.969	.6183		sig
p1-5mm	Thin	49	1.622	.4892	-2.488	0.015
	Thick	16	1.969	.4644		sig
p1-7mm	Thin	49	2.220	.6764	-.317	0.752
	Thick	16	2.281	.6316		
p2-3mm	Thin	49	1.059	.1755	-3.733	0.002
	Thick	16	1.450	.4066		sig
p2-5mm	Thin	49	1.420	.4664	-.466	0.643
	Thick	16	1.494	.7479		
p2-7mm	Thin	49	1.612	.7245	-2.117	0.038
	Thick	16	2.037	.6043		sig
M-3mm	Thin	49	1.006	.0242	-.901	0.382
	Thick	16	1.063	.2500		
M-5mm	Thin	49	1.153	.3847	1.825	0.073
	Thick	16	1.038	.1258		
M-7mm	Thin	49	1.149	.3577	-1.586	0.118
	Thick	16	1.313	.3594		

gingival thickness with C, P1, P2 & M1 .p value <0.05 was significant. The software used is SPSS version 17.

Results

Analysis of palatal masticatory mucosa at each measurement point indicated that:

- Mean thickness of canine at 3mm, 5mm and 7mm are more in the gingival thick group than in a thin group and it differs significantly (P<0.05). Mean thickness of P1 at 3mm and 5mm is more in the gingival thick group than in a thin group and it differs significantly (P<0.05). Mean thickness of P1 at 7mm does not differ between thick and thin gingival group (Table I).

- The mean thickness of palatal masticatory mucosa on thick and thin phenotype at the 7mm line ranged about 2.442mm and 2.318 mm at the canine region, 2.235 mm and 2.220 mm at the first premolar region, 1.717 mm and 1.612 mm at second premolar region, 1.189 mm and 1.149 mm in the first molar region. The palatal masticatory mucosa was thickest in the canine region, followed by premolars. The exception was at the first molar region on the 7 mm line, where the mucosa was considerably thin when compared to canine and premolars on the same line. (Table I)

- There was a significant positive correlation between gingival thickness and thickness of palatal masticatory mucosa in relation to canine at 3mm, 5mm, 7mm, first premolar at 3mm, 5mm, second premolar at 3mm, 7mm and first molar in relation to 7mm (Table II).

The results of the present study showed that the overall gingival phenotype in the study population - Dakshina Kannada region patients, referred to the Department of Periodontics for recession coverage were of thin phenotype and the thin phenotype was seen more in the female when compared to males (Graph I).

Discussion

The assessment of the thickness of keratinized gingiva and the palatal masticatory mucosa is a standard practice in dentistry that helps in better preoperative

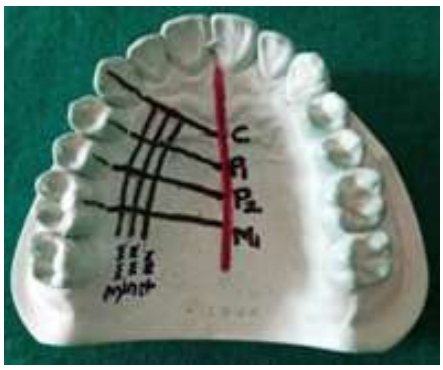


Figure I:PMM thickness assessment


Figure II: Armamentarium


Figure III:Gingival phenotype assessment

TABLE II: Correlations between Gingival Phenotype and PMM

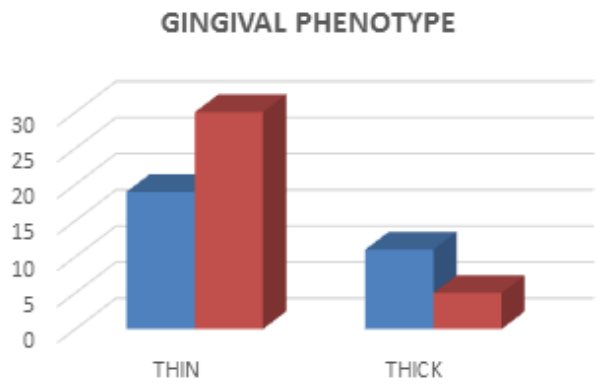
		C-3mm	C-5mm	C-7mm	p1-3mm	p1-5mm	p1-7mm	p2-3mm	p2-5mm	p2-7mm	M-3mm	M-5mm	M-7mm
G thickness	Pearson Correlation	.686*	.460*	.369*	.582*	.358*	.162	.506*	.233	.363*	.180	-.048	.278*
	P	0.001	0.001	0.002	0.001	0.003	0.196	0.001	.062	.003	.151	.702	.025
	N	65	65	65	65	65	65	65	65	65	65	65	65

* Correlation is significant

diagnosis and treatment planning. Taking into account the usefulness of the palatal mucosa in periodontal plastic procedures and implant therapy, it is quite evident that this tissue holds a prominent position in the current era of soft tissue aesthetics in dentistry.[7]

In the present study, the posterior palatal mucosal thickness was assessed in sixty-five healthy non-periodontitis patients at twelve points on three different lines running parallel to the gingival margin at 3, 5, and 7mm respectively, which were established starting at the mid-palatal aspect of the canine and ending over the palatal root of the first molar. Four points (C, P1, P2, M1) were defined on each of the three lines, constituting four positions, each located at the level of a tooth, designated for assessing the palatal mucosa thickness in the hard palate by bone sounding using a sterile endodontic spreader (#20) fitted with a silicone stop. The recordings were rounded off to the nearest millimeter. Similar gingival thickness evaluation of posterior palatal mucosa was done in a study conducted by Studer et al,[8] Khatri M et al,[1] Wara-aswapati N,[9] Kolliyavar B,[7] Muller HP[12]. Bone Sounding is a relatively reliable method for determining the bone level; and it has been previously suggested by Terakura T et al,[10] Studer et al,[8] Mealey B et al,[11] Wara-aswapati N[9] et al.

The present study showed that the palatal masticatory mucosa was thickest in the canine region, followed by premolars. The exception was at the 1st molar region, where significantly thinner mucosa was observed. Similar to the previous reports by Studer et al,[8] Muller et al,[12] Wara-aswapati N et al,[9] the palatal mucosal thickness adjacent to the palatal root of the first molar provided limited donor tissue volume for graft harvesting. This represents an anatomical barrier in graft harvesting. Canine and premolar areas appear to be the most appropriate donor site for grafting procedures.



Graph I: Reveals Gingival phenotype of the study population.

In the present study, the result demonstrated that the overall gingival phenotype in the study population was of thin phenotype. The thin phenotype was seen more in the females when compared to males (Graph I), which was compatible with Vandana KL[6] et al, a study among Indian population. Another study by Shah R et al[13] in Karnataka population concluded that the prevalence of thick and thin gingival biotype is 56.75% versus 43.25%. A study done on Asian population by Wara-aswapati N[9] et al showed that females had thinner mucosa than males. Whereas, Studer et al[8] study among Caucasians showed that the majority were of thick phenotype which would be due to the ethnic differences.

An epidemiological study on the gingival recession by Mythri S et al,[14] among Mangalore patients revealed that of 710 subjects examined, 291 (40.98%) subjects exhibited gingival recession. Approximately half of the subjects examined exhibited gingival recession and the most common cause for the gingival recession was dental plaque accumulation (44.1%) followed by faulty tooth brushing (42.7%).

Thick gingival tissues are relatively dense in appearance with a rather wide zone keratinized gingiva, flat bony architecture, resistance to acute trauma, eases manipulation, maintain vascularity, and promote wound healing during and after surgery. On the other hand, a thin biotype is delicate and translucent, friable with a minimum zone of attached gingiva, thin bony architecture and may lead to recession after trauma, surgical, or inflammatory injuries. They have been associated with a compromised soft tissue response following surgical and or restorative treatment[13,15,16].

Within the limits of the present study, it is demonstrated that there is a positive association between the gingival phenotype and the thickness of palatal masticatory mucosa. (Table II) which was previously

reported in the study conducted by Müller HP[12] et al, Yaman D[2] et al, that the thickness of masticatory mucosa strongly depends on the periodontal phenotype.

The treatment modalities can be altered according to the gingival phenotype. In case of thin phenotype harvesting of subepithelial connective tissue graft can be done according to the concept of the de-epithelialized grafts, that is de-epithelialization of free gingival grafts using a sharp blade extra orally.[17] Other factors that may influence the thickness of palatal mucosa such as genetic factors and body weight need to be investigated.

Conclusion

The assessment of the thickness of keratinized gingiva, the palatal masticatory mucosa has emerged as the standard practice in dentistry that helps in better preoperative diagnosis and treatment planning. The findings of the study can be summarized as follows

- There is a significant positive correlation between gingival thickness and thickness of palatal masticatory mucosa.

- Canine and premolar areas appear to be the most appropriate donor site for grafting procedures.

- The palatal mucosal thickness adjacent to the palatal root of 1st molar provided limited donor tissue volume for graft harvesting.

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Comparision of green tea toothpaste and regular toothpaste in control of gingivitis

Pratiksha Bordoloi[1], Amitha Ramesh[2], Biju Thomas[3]

ABSTRACT

Background: Dental plaque is considered to be the main etiology behind gingivitis and periodontitis. Various mechanical and chemical plaque control agents aid to control it. Among all, toothpaste is the most commonly used and with increasing awareness the popularity of herbal toothpaste has increased.

Materials and methods: Twenty systemically healthy subjects with chronic generalized marginal gingivitis between the age group of 25-45 years were selected. They were randomly divided into two groups- Group I (regular toothpaste) Group II (commercially available green tea toothpaste). Gingival Index and Simplified Oral Hygiene Index were recorded at baseline and 14 days after the use of toothpaste. The subjects were given oral hygiene instructions and were advised to brush twice daily using Modified Bass Technique and the toothpaste for 14 days.

Results: The independent t-test was used to test the significance in reduction of both Gingival Index (GI) and Simplified Oral Hygiene Index (OHI-S) in the two groups over the period of study. Both Gingival Index and Simplified Oral Hygiene Index has significantly reduced ($p < 0.05$) in both the groups as recorded in day 0 and 14. The difference in OHI-S in Group II was more significant.

Conclusion: The efficacy of green tea toothpaste was found to be similar with that of the regular tooth paste for the control of gingivitis.

Keywords: green tea, dental plaque, gingivitis, periodontitis

Introduction

Dental plaque is established as the principle etiological agent of dental caries and periodontal disease. Genco, in 1990 stated that "gingivitis is inflammation of gingiva when the junctional epithelium remains attached to the tooth at the original level." Gingival bleeding is the early indication of gingivitis. In 1971, Muhlemann demonstrated that bleeding from the gingival sulcus was the earliest clinical sign of gingivitis and it precedes discolouration and swelling of the gingival units. Lennox and Kopezyk noted that bleeding points do not correlate directly with clinical inflammation but rather precede apparent inflammation.[1]

Recent investigations have stated that gingivitis develop within 2 weeks without proper oral hygiene and early carious lesions may be detected after about four weeks, when the plaque is allowed to accumulate.[2] Prevention of these two oral diseases in individuals is based on the effective removal of plaque on a daily basis. The presence of plaque could be the etiologic factor for dental caries, gingivitis, periodontal problems and halitosis.

[1]PG Student, [2,3]Professor, Department of Periodontics, AB Shetty Memorial Institute of Dental Sciences, Deralakatte, Mangalore - 575 018. Corresponding author: Prof (Dr) Amitha Ramesh, Email: amitharamesh71@yahoo.in

Many mechanical aids are used to control plaque, including brushes, dental floss, mouth rinses, and dentifrices.[3] Toothpaste is a paste or gel dentifrice used with a toothbrush to clean and maintain the aesthetics and health of gingiva and teeth. It serves as an abrasive that aids in removing dental plaque and food from the teeth. There are numerous toothpastes available. In the last decade, many consumers have switched over to herbal toothpastes in order to avoid synthetic and artificial flavors commonly found in regular toothpastes.

Green tea *(Camellia sinensis)* has received considerable attention because of its numerable scientifically proven health benefits attributable to the presence of various polyphenols.[4,5] Several epidemiologic and experimental observations in the field of medicine and dentistry have suggested that green tea catechins may exert cardioprotective, antioxidant, cholesterol-lowering, anti-obesity, anti-diabetic, anti-cancer, anti-inflammatory, anti-caries, anti-bacterial, anti-fungal, and anti-viral effects.[6-8] Epigallocatechin gallate (EGCG), the most abundant polyphenol component in green tea, inhibits the activity of collagenase and gelatinase. It is responsible for all these diseases preventing properties.[9-11]

Aim

To compare the efficacy of green tea toothpaste and regular toothpaste in the control of gingivitis.

Objectives

1. To clinically evaluate the efficacy of green tea toothpaste to control gingivitis.
2. To clinically evaluate the efficacy of regular toothpaste to control gingivitis.
3. To compare the efficacy of green tea toothpaste and regular toothpaste to control gingivitis.

Materials And Methods

Participant selection

Twenty systemically healthy subjects with chronic generalized marginal gingivitis between the age group of 25-45 years visiting the Department of Periodontics, A.B. Shetty Memorial Institute of Dental Sciences, Mangaluru were selected. The sample size was found to be sufficient when power calculations were made prior to the beginning of the study. Informed consent was taken from the subjects prior to their participation. Ethical clearance was obtained from the institutional ethical committee.

The subjects were divided into two groups randomly-

Group I: 10 subjects were given regular toothpaste

Group II: 10 subjects were given commercially available green tea toothpaste

The toothpaste was dispatched in a container to the subjects. The subjects were blinded so that there was no bias. The subjects were instructed to brush twice daily for 2 minutes using a pea-sized amount of the toothpaste. The subjects received demonstration of brushing technique- Modified Bass Technique, and were advised to follow this technique of brushing. They were suggested to report after 14 days for follow up.

Inclusion criteria

Subjects were included if he/ she satisfied all the following criteria-

- Minimum complement of 20 teeth present.
- Subjects with Gingival Index score of 1.1-2 (moderate gingivitis).[12]
- Subjects with Simplified Oral Hygiene Index score of 1.3 – 3.0 (fair)[12]
- Patients who are not allergic to green tea or any kind of toothpaste component.

Exclusion criteria

Subjects were excluded if any of the following criteria is present-

- Presence of any systemic disease.
- History of periodontal treatment in past 6 months.
- Use of medication like NSAIDS, antibiotics or any drug known to influence periodontal

tissues in the past 6 months.

- Pregnant or lactating women.
- Any habits present (smokers/ pan chewers).

Screening examination

Gingival Index (GI) and Simplified oral hygiene index (OHI-S) were recorded at baseline and 14 days after the use of toothpaste. Toothpaste was asked to be used twice daily for 14 days.

Statistical Analysis

The sample size for the study was fixed at twenty. They were further divided randomly into two groups i.e, Group I and Group II, each consisting of 10 subjects. The results were statistically analyzed using paired t-test for difference over the period of 14 days. The independent t-test was used to test the significance in reduction of both Gingival Index (GI) and Simplified Oral Hygiene Index (OHI-S) in the two groups over the period of study.

Table 1- Mean GI and OHI-S in both the groups

Indices	Group I	Group II
GI-0	1.59	1.61
GI-14	1.27	1.10
OHIS-0	2.41	2.23
OHIS-14	1.96	1.46

Table 2- Correlation between GI and OHI-S on 0th and 14th day

	N	Correlation	Sig.
GI-0 & GI-14	10	.668	.035
OHIS-0 & OHIS-14	10	.787	.007

Results

The twenty subjects consisted of 11 males and 9 females in the age group of 25-45 years. Gingival Index (GI) and Simplified Oral Hygiene Index (OHI-S) were recorded on baseline i.e, 0th day (GI-0 and OHIS-0) and on 14th day (GI-14 and OHIS-14). The mean reading for GI-0 was 1.59, GI-14 was 1.27, OHIS-0 was 2.41 and OHIS-14 was 1.96 in Group I and GI-0 was 1.61, GI-14 was 1.10, OHIS-0 was 2.23 and OHIS-14 was 1.46 in Group II (Table 1).

Both GI and OHI-S has significantly reduced ($p< 0.05$) in both the groups as recorded in day 0 and 14. (Table 2) This could be mostly due to the oral hygiene instructions which were given to all the subjects and the significant result shows that all the subjects have followed them judiciously. Thus, both regular toothpaste and green tea toothpaste are effective in controlling gingivitis.

However, the difference in OHI-S in Group II (the subjects who were given commercially available green tea) was more significant as $p=0.01$ ($p< 0.05$). (Table 3) This could be due to the beneficial effects of green tea in maintaining the overall health of the gingiva and periodontium.

Discussion

In recent times, there has been a renewed interest in using herbal based products. In the indigenous systems of medicine, different components of different plants have been used in medicinal preparations to clean teeth or to treat oral diseases including peri-

Table 3- Correlation of GI and OHI-S on 0th and 14th day in Group II

	Paired Differences					t	df	Sig. (2-tailed)
	Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
				Lower	Upper			
GI-0 & GI-14	.51000	.28460	.09000	.30641	.71359	5.667	9	.040
OHIS-0 & OHIS-14	.77000	.49001	.15496	.41947	1.12053	4.969	9	.001

odontal disease.[13-15] Herbal-based toothpastes are as effective as the conventionally formulated dentifrice in the control of plaque and gingivitis.[16]

Green tea *(Camellia sinesis)* is one of the most popular beverages in the world. Recently, it has received considerable attention because of its numerable scientifically proven health benefits attributable to the presence of various polyphenols. Several epidemiologic and experimental observations in the field of medicine and dentistry have suggested that green tea catechins may exert cardio-protective,[17] antioxidant,[18] cholesterol-lowering,[19] anti-obesity,[20] anti-diabetic,[21-23] anti-cancer,[24] anti-inflammatory,[25] anti-caries,[26,27] antibacterial, anti-fungal, and anti-viral effects.[28] These effects have been primarily attributed to the most prevalent polyphenol contained in green tea, epigallocatechin gallate (EGCG). Some studies have reported that EGCG inhibits the activity of collagenase and gelatinase.[29,30]

Bacterial biofilm development in the marginal gingiva and periodontal pockets is important in the pathogenesis of periodontal disease. Tooth brushing has remained the gold standard in maintaining oral hygiene. Green tea catechin has shown to be effective in altering the flora and acting as an adjunct to scaling and root planning.[31] Oxidative stress plays a vital role in the pathogenesis of periodontal disease, as well as many other disorders and it is believed that antioxidants can defend against inflammatory diseases.[32] Similar mechanisms might be involved in the effects of the intake of green tea. Rasheed and Haider described the antibacterial effect of green tea catechins against Streptococcus mutans bacteria and stated that catechins were of great value in reduction of S. mutans and caries prevalence.[33]

In this study there was a significant difference in the OHI-S in Group II. The plaque inhibitory effect which was seen in Group II can be attributed to the ability to remove dental plaque bacteria from teeth. Many of the biological properties of green tea have been ascribed to the catechin fraction, which has certain therapeutic and biological properties. Catechin is found to have antiplaque and antibacterial properties and contributed in caries prevention and gingival enhancement. Catechin gallates (CGs) such as epicatechin gallate (ECG) intercalate into phospholipid bilayers and it is likely that they effect both virulence and antibiotic resistance by perturbing the function of key processes associated with the bacterial cytoplasmic membrane.[34] It exerts inhibitory effect on S. mutans growth, which are mainly responsible for caries and gingivitis. Catechins found in green tea have marked effect on pH value of saliva and dental plaque and preserve it in normal range (7.2-7.4), which is not a favorable condition for S. mutans.[35] According to a pilot study conducted by Awadalla et al. in 2011, green tea has inhibitory effect on S. mutans count, gingival bleeding and acidic plaque.[36]

The property of Porphyromonas gingivalis to adhere onto oral epithelial cells is strongly correlated with the cause of periodontal disease. In a study conducted by Sakanaka et al. in 1996, CGs, especially epigallocatechin gallate (EGCG) (active at 250-500 μg/ml), inhibited growth and adherence of P. gingivalis to buccal epithelial cells.[37] The number of adherent bacterial cells decreased in a dose dependent manner. They postulated that the underlying mechanism of adherence inhibition by tea polyphenols is the result of the binding of tea polyphenols to fimbria of P. gingivalis. Hirasawa et al. demonstrated bactericidal activity of green tea catechins at 1 mg/ml against species of Prevotella and P. gingivalis and found a significant reduction in markers of gingivitis after the use of a slow-release buccal delivery system applied over a period of 8 weeks.[38] Green tea catechin also has an inhibitory effect on collagenase activity, thus limiting tissue destruction. It significantly reduces the expression of matrix metalloproteinase-9 in osteoblasts and also inhibits the formation of osteoclasts. Thus, EGCG may prevent alveolar bone resorption that occurs in periodontal disease.[39,40]

Ramesh A et al in 2017 conducted a study to evaluate the efficacy of green tea tablet on moderate gingivitis and to measure the tooth stain index following oral intake of the green tea tablet. They concluded that green tea tablets could be effective in the treatment of moderate gingivitis and it would be advisable to use green tea tablet adjunctive to oral prophylaxis to reduce staining of the teeth.[41]

In this study the efficacy of regular toothpaste and commercially available green tea toothpaste has been compared over a 14 day period. One shortcoming

of this study is small sample size and the time period for which this study was done. Further studies can be done with a bigger sample size and for a longer period of time.

Conclusion

The efficacy of green tea toothpaste was found to be similar with that of the regular tooth paste for the control of gingivitis. However, when the clinical parameters such as Gingival Index (GI) and Simplified Oral Hygiene Index (OHI-S) were compared in both the groups, a more significant result was seen in the OHI-S in the group using green tea toothpaste.

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An Interdisciplinary Approach in Management of Complicated Crown Root Fracture

Reesa Babu[1], Jincymol K I[1], Tharian B Emmatty[2],Bijimole Jose[3], Jose Paul[4], George Jose[5]

ABSTRACT

An eleven and a half year old boy reported with anterior tooth trauma to the Department of Pedodontics and Preventive dentistry in Annoor dental college. The case was diagnosed as a complicated crown root fracture in tooth number 11. A comprehensive treatment plan was formulated to do an interdisciplinary treatment consisting of orthodontic extrusion, fibre reinforced post and core and crown. Following orthodontic extrusion, since the crown was short, a crown lengthening with apically displaced flap and osteotomy was also done. After complete wound healing, an acrylic jacket crown was fabricated.

Keywords: trauma, complicated crown root fracture, orthodontic extrusion, crown lengthening, fibre post

Introduction

Traumatic injuries to dentition are common in children and young adults. They are often referred to as Traumatic Dental Injuries (TDI). TDI's comprise 5% of all injuries.[1] In primary dentition; luxation injuries are more common whereas crown fractures are more frequent in permanent dentition. According to dental trauma guidelines 2012, International Association of Dental Traumatology (IADT) 25% of all school children and 33% of adult before the age of 19 experience dental trauma. The three golden rules in management of such cases are proper diagnosis, treatment planning and follow up. IADT has published a set of guidelines for the proper management of such cases. Following these guidelines can maximize the chances for a favorable outcome.[2] The present case reports the management of such a traumatic injury to the dentition.

Case Report

An eleven and a half year old boy reported to the department of Pedodontics with a trauma of upper front tooth. The patient gave a history of dental trauma one week prior to reporting due to fall from bicycle and he had taken medication for pain relief at the time of trauma. The case was diagnosed as a complicated crown root fracture of 11. The medical history of the patient indicated that he was in good health and had no systemic diseases.

Clinical Findings

A complicated crown root fracture involving fracture of enamel, dentin and cementum with exposure of pulp was noticed (figure 1).The tooth was tender on percussion. The coronal fragment was mobile.

Radiographic Findings

Intra oral peri apical (IOPA) radiograph of 11 showed radiolucency involving enamel, dentin and cementum involving pulp chamber space indicative of complicated crown root fracture with a closed apex (figure 2).

Treatment Plan

Usually, the majority of TDIs occur in children and teenagers where loss of a tooth has lifetime consequences. The immature permanent tooth has considerable capacity for healing after traumatic pulp exposure,

[1]Post graduate student, [2] Professor and HOD, [3] Reader, Department of Pediatric and Preventive Dentistry; [4]Prof and HOD, Dept of Periodontics; [5] Professor, Dept of Orthodontics, Annoor Dental College and Hospital, Muvattupuzha. Corresponding Author: Dr. Reesa Babu; Email: reezkj@gmail.com

luxation injury and root fractures. In this case as the apex was completed, removal of the coronal fragment with subsequent endodontic treatment and restoration with a post retained crown was planned. Orthodontic extrusion as well as surgical crown lengthening was also planned if required.

Department of Orthodontics regarding extrusion possibilities, it was decided to perform an endodontic treatment followed by orthodontic extrusion by using 2x4 appliance was planned. After completion of RCT, a fibre reinforced post was planned for clinical crown and bracket attachment (figure 3).

The classical 2x4 appliance is bracketing the 4 anteriors for intruding or aligning the anteriors. In this case, molar bands were placed and anteriors 12,11,21,22 were bracketted and a vertical offset bend was given in the sequential archwire. Since the lower anteriors were flaring, lower anteriors were retroclined using archwires, bracketing only the anteriors. It took about 6months for the desired extrusion and crown clearance to take place. (figures 4 &5).

Slow extrusion of tooth also brings the bone and gingiva alongside. Although the tooth was extruded, the crown structure was insufficient to give a crown (figure 4). The case was referred to the Department of Periodontics. It was decided to do a frenectomy followed by an apically repositioned flap and osteotomy. Following frenectomy, apically displaced flap was done after 1 month to preserve whatever attached gingiva was present. Sling sutures and simple interrupted sutures were placed with 5-0 silk (figures 6 & 7). Antibiotics and analgesics were given for 5 days.

Following adequate healing after 2 months, the smile was restored with an acrylic jacket crown. (figures 8 & 9).

Discussion

Traumatic injuries of the teeth and their supporting structures has been and continues to be a challenge, which every dental professional must be prepared to assess and treat efficiently. Extraction should not be the first choice of treatment for such cases, especially in the anterior region; instead, alternative treatment

Fig 1: Clinical exposure of pulp

Fig 2: Radiograph of 11

Fig 3: Fibre reinforced post

Fig 4: Orthodontic extrusion

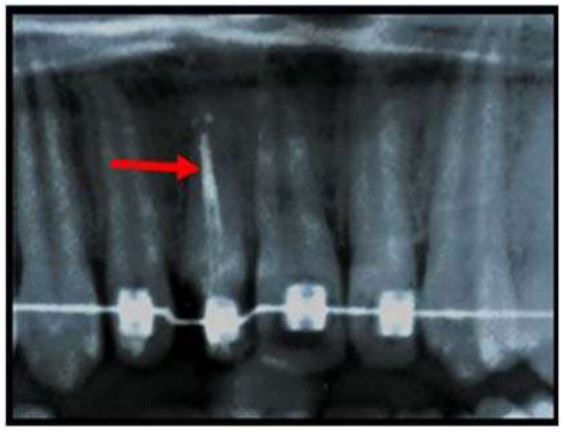

Fig 5: Radiograph showing extrusion of 11

modalities must be considered. Various treatment approaches have been indicated for fractured teeth including:[3]

- Fragment removal followed by restoration[4]
- Fragment reattachment[5]
- Gingivectomy and osteotomy (crown lengthening)[5]
- Orthodontic extrusion with/without gingivoplasty[4,5]
- Forced surgical extrusion[4,5]
- Vital root submergence[5]
- Extraction followed by surgical implants or fixed partial denture or removable partial dentures.[5]

Clinical considerations for the management of crown-root fractures include:[6]

- Extent and pattern of fracture
- Restorability of remaining tooth segment
- Bone support available and its quality
- Damage to the attachment apparatus
- Availability of fractured fragment
- Patient cooperation
- Age of the patient
- Esthetics expected by the patient and practically achievable.

Each tooth with complicated crown root fracture has its uniqueness and challenges that need to be taken into consideration during the treatment planning stage.[7] Controlled orthodontic extrusion is also called as forced eruption, orthodontic eruption, vertical extrusion or assisted eruption and was first reported by Heithersay and Ingber.[8,9] It can be carried out with removable or fixed orthodontic appliances, the former using mostly elastic bands or magnets and fixed appliances with many modifications.[10,11] The purpose of

Fig 6: Frenectomy

Fig 7: Crown lengthening procedure

Fig 8: Acrylic jacket crown

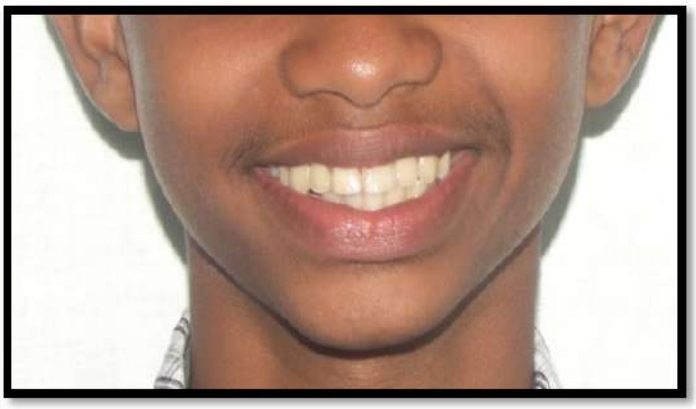

Fig 9: Post op smile of the patient

this method is not the correction of tooth position in the arch as in conventional orthodontic treatment but to preserve the biologic width, which is essential for successful prosthetic rehabilitation.[12] Additional advantage of forced eruption is that the adjacent teeth need not be prepared for fixed prosthesis and alveolar bone is conserved. Although orthodontic extrusion reduces crown/root ratio and widens the embrasure, this approach allows maintenance of the biologic width and optimizes the marginal sealing of the restoration as it moves the fracture line supragingivally. Here in this case in order to obtain adequate crown clearance, we used fixed 2x4 appliance to extrude and align the upper incisor as well as retrocline the lower incisor.

To convert the subgingival fracture to a supragingival level, the help of gingivectomy and osteotomy procedures may be utilized.[13] Periodontal and osseous recontouring allows exposure of the fracture margin and sufficient root surface to give an acceptable restorative finish line.[14] Frenectomy procedures are indicated in case of an aberrant frenum with an inadequately attached gingiva and a shallow vestibule.[15] Frenectomy is the complete removal of the frenum, including its attachment to the underlying bone.[16] Frenectomy followed by an apically repositioned flap was done to gain adequate width of attached gingiva. Frenectomy was done to remove the interference of high frenal attachment and to avoid relapse. Since the patient has to undergo further fixed orthodontic correction for his malaligned teeth, we tried to restore his smile using an acrylic jacket crown. An important aspect for consideration here is the patient cooperation. Excellent patient cooperation is required for maintenance of proper oral hygiene, use of the orthodontic appliance and periodic visits for activation and assessment. He was an excellent patient in cooperativeness and strictly adhered to his follow up appointments, so we were able to complete our tiny attempts to the desired success level.

Conclusion

Trauma is always a deeply distressing experience physically as well as emotionally. Especially in children, this may result in psychological imbalance and may lead to loss of self confidence and even low self esteem. Hence the timely as well as necessary management of such traumatic cases are very essential for the complete well being of the child physically, socially and emotionally. This case shows the importance of timely intervention of various fields of dentistry in a dental trauma case. Various dental fraternities should join hands with each other at the right time without delay to achieve the best possible outcome for the patient.

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Pyogenic Granuloma: A Case Report

Anu Vijayan[1], Pooja Sam[2], Sam Sunny[3], Pravallika Kakulla[4], Atheena Saran Antony[5], Aimy Johnson[6]

ABSTRACT

Pyogenic Granuloma (PG) is a benign vascular tumor that occurs in all ages. It is a reactive or reparative response to factors such as local irritation, physical trauma, food impaction, periodontitis or hormonal factors. In this case report, pyogenic granuloma of a 37 year old female is discussed.

Key words: Pyogenic Granuloma, food impaction, periodontitis.

Introduction

The inflammatory gingival enlargement is caused by tissue edema and infective cellular infiltration caused by prolonged exposure to bacterial plaque, and is treated with conventional periodontal treatment such as scaling and root planing. The pyogenic granuloma in oral cavity appears as a gum bump. The most common site is gingiva (75%).[1] In rare cases it can be seen in extra gingival sites. Color ranges from bright red / pink and in rare cases magenta / purple. It grows rapidly and can be smooth or lobulated. Young lesions are more likely to be red because of the high number of blood vessels. Older lesions tend to be pink in color. Size ranges from millimeter to centimeter although smaller or larger lesions may occur. A pyogenic granuloma can be painful if it's located in an area of the body where it's constantly disturbed. It may be single nodule or sessile papule with a smooth or lobulated surface. Anterior facial gingiva is most commonly affected than posterior gingiva.[1] It's more common in females than males.[2] It can arise spontaneously in sites of injury, or within capillary malformations.[3,4] In pregnant women, lesions occur in first trimester with an increased incidence up until the seventh month. This can also be associated with the use of certain medications such as oral contraceptives, retinoids etc. The lesion can also mimic various other vascular lesions, solid tumors and soft tissue infections.

Histology and Pathogenesis

Histologically, pyogenic granuloma has lot of capillaries and venules with plump endothelial cells separated into lobules by fibromyxoid stroma. The development can be classified into (1) Cellular phase (2) Capillary or vascular phase (3) Involutionary phase. Slow fibromatous regression is seen in untreated lesions after long time. Of pathogenetic importance are trauma, BRAF mutations,[4] herpes virus type 1 and human papilloma virus type 2.[5] These viruses are indirect factors stimulating angiogenesis in pyogenic granuloma.

Case Report

A 37 year old systemically healthy female subject came with the chief complaint of a swelling in the gums since two years. The lesion was of a size of a small peanut when she noticed it initially and gradually increased to attain the present size. Clinical examination revealed an exophytic growth seen on the left anterior

[1]Associate Professor, Department of Oral Medicine and Radiology, Mar Baselios Dental College, Kerala; [2]Dental Shadowing, United Smiles Dental Clinic, Richmond, Virginia,USA; [3]Medical Technologist, Ouchita County Medical Center, Camden, Arkansas, USA; [4] Dental Assistant, Smile Family Dentistry, Dallas, Texas USA; [5]Dental Assistant, Reddy Dental Associates, New York, USA; [6]Dental Shadowing, United Smiles Dental Clinic, Richmond, Virginia, USA Cooresponding author : Dr Pooja Sam E mail: poojabenny18@gmail.com

tooth region in the interdental aspect of 32, 33 of size approximately 1cm *0.8 cm extending anteroposteriorly from distal aspect of 32 to distal aspect of 33, superoinferiorly from the interdental gingiva to the mucogingival junction (Figure-1). On palpation, the growth was tender, soft to firm in consistency, pedunculated (Figure-2) and bleed easily on slight touch. The subject had a poor oral hygiene status and growth had no interference with the occlusion.

After obtaining the subject's consent, surgical excision of the growth was planned and scheduled. Under premedication, local anesthesia was administered and the growth was excised from the base (Figure-3). Debris were flushed out under irrigation and flaps were loosely closed. To prevent further irritation and promote proper healing, Coe-pack was given (Figure-4).The patient was instructed to use chlorhexidine mouthwash for once daily and should report back in two weeks. After review, the post excision site exhibited uneventful healing (Figure-5).

On histopathological examination, thin stratified squamous epithelium and underlying connective tissue with haphazardly arranged dense collagen fibers and numerous blood vessels lined by endothelial cell proliferation were seen (Figure-6). Chronic inflammatory cells were also noted. These findings were suggestive of pyogenic granuloma.

As part of management, the treatment plan was briefly explained to the subject. The initial treatment was excision and biopsy followed by histopathologic examination. Deep scaling and root planing was done and the patient was instructed methods to maintain proper oral hygiene. The treatments improved the esthetic appearance of her smile. Patient was kept under regular intervals of review.

Discussion

The term *pyogenic granuloma* is misleading as it is not a true granuloma. In actuality, it is a capillary hemangioma of lobular subtype, hence such a lesion is prone to bleeding. Additionally, it is also not truly pyogenic (pus-producing), as the cause is hormonal or traumatic and has no association with infection or pus production.

Fig 1: Exophytic growth seen on the left anterior tooth region in the interdental aspect of 32, 33 of size approxcmimately 1*0.8 cm extending from distal aspect of 32 to distal aspect of 33.

Fig 2: The mass is pedunculated

Fig 3: Excisced 1cm *0.8 cm sized mass

Fig 4: Coe-pack placed post operatively

Fig 5: Two weeks post operative

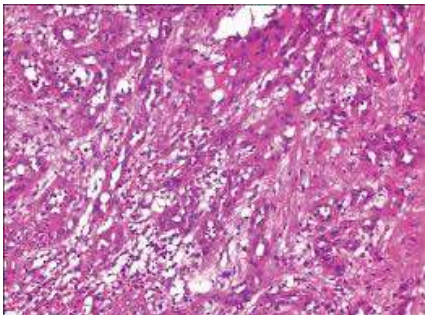

Fig 6: Excess of endothelial cells

Anitua and Pinas[6] conducted a study and found that pyogenic granuloma is caused by accumulation of dental plaque and improper prosthetic design with flanges causing difficulty in maintaining good oral hygiene. This can also be seen in cases of dental implants.

Pyogenic granuloma is caused by a known stimulant such as calculus or foreign material in the gingival crevice resulting in a proliferation of connective tissue.[2] In addition, one-third of the lesions occur after trauma. Ainamol suggested that routine tooth brushing habit caused repeated trauma to gingiva, resulting in these lesions.[7] Furthermore, release of variety of endogenous substances and angiogenic factors, trauma to the deciduous teeth,[8] aberrant tooth development,[9] occlusal interferences,[10] drugs such as cyclosporine[11] and selection of wrong healing cap for implants are some of the precipitating factors for PG.[6]

Oral PGs occur in all age groups, children to older adults, but frequently seen in females in the second decade due to increased levels of hormones.[12] Gingiva is affected primarily, especially the marginal gingiva and common in maxillary than mandibular gingiva. Anterior areas are more frequently affected than posterior areas. All these lesions are more common on the facial than the lingual aspect. Clinically, the lesion can be slow-growing, asymptomatic and painless, but it may grow rapidly occasionally.[2] Radiographic findings are usually absent,[13] however, some long standing gingival PGs can cause localized alveolar bone resorption.[14] Differential diagnosis includes peripheral giant cell granuloma, peripheral ossifying fibroma, metastatic cancer, hemangioma, pregnancy tumor, hyperplastic gingival inflammation, Kaposi's sarcoma, bacillary angiomatosis, angiosarcoma, and non-Hodgkin's lymphoma.[5] Peripheral giant cell granuloma is clinically similar to PG, but cupping bone resorption in radiograph and appearance of multinucleated giant cells are differentiating features.[2] Fibroma can be distinguished by the consistency, texture, and the lighter color.[5] Metastatic tumors, even though clinically resembles PG, the microscopic appearance resemble as the tumor of origin.[5] Hemangioma is a developmental disorder and is most commonly seen on the tongue. It can be multinodular, bluish red and can be diagnosed by a chairside procedure called diascopy.[3] Kaposi's sarcoma and bacillary angiomatosis can be differentiated histopathologically and are commonly AIDS related.[15] Pregnancy tumor occurs towards the end of pregnancy, and the tendency for this lesion to shrink after delivery indicates the definite role in etiology of lesions. Also, pregnancy tumor is usually confined to the interdental papilla.[4] PG can be distinguishable from angiosarcoma by its lobular growth pattern, well-formed vessels and cytologically bland endothelial cells.[4] Clinical appearance of gingival non-Hodgkin's lymphoma varies but is usually found to be an asymptomatic gingival enlargement or mass resembling a PG.

Conclusion

The case report emphasises that the diagnosis of oral lesions is complex and leads the dentist to consider distinct lesions with different diagnostic methods. From clinical examination, the local irritation of plaque is the main etiologic factor for the pyogenic granuloma in this case. The histology proved the diagnosis accurately. A better treatment can be planned from the investigations. The progression of the granuloma can be stopped, restoring the patient's normal function and improving the esthetics.

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Pink Esthetics With Diode Laser: Two Case Reports

Sanjeev R[1], Neeraja[2], Ajith S[3]

ABSTRACT

Gingival hyperpigmentation or "black gums" which is caused by deposition of melanin pigment is a major esthetic concern for many people in this modern era although it is not a medical problem. For de-pigmentation of gingiva, different treatment modalities have been reported such as bur abrasion, scraping with scalpel, partial thickness flap, gingivectomy, cryotherapy, electrosurgery, lasers, free gingival autografting, sub-epithelial connective tissue graft and combination techniques. In the present case reports, LASER surgery was performed for gingival de-pigmentation. The esthetic results were pleasing and healing was uneventful. Patient was satisfied with the outcome at three month follow-up as evidenced from the feedback.

Key words: depigmentation, Diode LASER, hyperpigmentation

Introduction

The gingiva consists of melanocytes, and the deposition of excessive melanin (non-hemoglobin derived pigment) by melanocytes (in the basal and supra-basal epithelia) can result in hyperpigmentation. Several different conditions, such as Peutz-Jeghers syndrome, Albright syndrome, melasma and Graves' disease, can result in high secretion levels of oral melanin.[1] Clinical melanin pigmentation of the gingiva is not a medical problem, although the presence of black gums may cause aesthetic issues, especially if the pigmentation is visible during communication.[2]

Dental laser energy has an affinity for different tissue components. The 810-nm diode laser has energy and wavelength characteristics that specially target the soft tissues. It has an affinity for hemoglobin and melanin, therefore it is more efficient and better equipped to address deeper soft tissue problems.[3] The treatment of gingival hyperpigmentation using a laser is gaining popularity. Most of the lasers used in dentistry, are of the infrared type. Research has shown that in cases of chronic periodontitis, the easy removal of infected epithelium can be achieved using a pulsed diode laser (810 λ). Using a laser, the gingival shape can be modified, the dependence on local anaesthesia is decreased, and the lowest amounts of post-operative pain and inflammation are experienced by the patient.[4]

Hyperpigmentation of the gingiva is considered based on Dummett–Gupta Oral Pigmentation Index (DOPI): (Dummett 1971)[5]

1. No clinical pigmentation (pink gingiva)
2. Mild clinical pigmentation (mild light brown color)
3. Moderate clinical pigmentation (medium brown or mixed pink and brown)

[1] Professor & Head, [2,3] Post Graduate student, Department of Periodontics and Implantology, PSM College of Dental Science and Research, Akkikavu, Thrissur, Kerala. Corresponding Author: Dr. Neeraja E mail: drneerajamani@gmail.com

4. Heavy clinical pigmentation (deep brown or bluish black)

The present cases in this report describe an effective surgical depigmentation technique with diode laser which has produced good results with patient satisfaction.

Case Reports

A 23-year-old female patient complaining of heavily pigmented gums [Figures 1-5], and a 21-year-old male patient with the same complaint [Figure 6-8] visited Department of Periodontics, PSM College of Dental Science and Research, Akkikavu, Thrissur. On examination, both the patients were otherwise healthy but had a deeply pigmented maxillary gingiva and in mandibular arch, the pigment was not that densely gathered as brown continuous band and the smile of these patients were not affected by this. Pigmentation was unsightly and hence laser depigmentation procedures were planned. The procedure was explained verbally to the patients and the consent was obtained. Blood investigation was carried out to rule out any contraindication for surgery. Oral hygiene procedures were performed and instructions were given. Under topical anesthetic spray, local anesthesia was infiltrated in the maxillary anterior region in a left quadrant from Canine to right quadrant Canine.

Patient and operating staff wore special diode-laser protective eye glasses. Highly reflective instruments or instruments with mirrored surfaces were avoided as there could be reflection of the laser beam. A diode surgical laser unit (Cheese diode, wavelength 810 nm, power 5 W) was used for depigmentation. The diode laser was emitted in continuous mode and operated in a contact method using a flexible fiber optic handpiece. Energy settings of 1.5-2 watts were used with small brush like strokes with gradual progression deeper along the same initial laser incision to remove the tissue. During the procedure, laser ablated the gingival epithelial surface little by little to reach the pigments without causing any bleeding. To enhance visualization, normal saline-soaked cotton or gauze

Case 1

Fig 1: Preoperative image showing pigmented gingiva

Fig 2: Laser application

Fig 3: Partially depigmentation done

Fig 4: Complete depigmentation (immediate post operative image)

Fig 5: Review after 6months

was used to remove epithelial remnant. The wound looked fresh with no bleeding. Topical application of vitamin E was done over operated area and patient was advised to continue vitamin E application for one week twice a day. Patient was instructed to avoid eating hot and spicy food for the first 24 hours. No infection or postoperative complications such as pain or bleeding were encountered at 1 week.

Case 2

Fig 6: Pre operative image showing pigmented gingiva

Fig 7 : Immediate post-operative image

Fig 8: Review after 1 month showing complete satisfactory healing

Discussion

Melanin pigmentation is frequently caused by melanin deposition by active melanocytes located mainly in the basal layer of the oral epithelium. Pigmentations can be removed for esthetic reasons. Different treatment modalities have been used for this aim (Pontes et al, 2006).[6] The selection of a technique for depigmentation of the gingiva should be based on clinical experience, patient's affordability and individual preferences.[7]

Lasers were introduced in 1960 by Maiman and were brought into general practice by Dr William and Terry Myers. Different lasers such as carbon dioxide (CO_2) laser, Nd:YAG laser, semiconductor diode laser, argon laser, Er:YAG laser and Er, Cr:YSGG laser have been reported as effective, pleasant and reliable method with minimal postoperative discomfort. The diode laser is a solid-state semiconductor laser that typically uses a combination of gallium (Ga), arsenide (Ar), and other elements, such as aluminum (Al) and indium(In), to change electrical energy into light energy. Dental laser energy has an affinity for different tissue components. The 980 nm diode laser has energy and wavelength characteristics that especially target the soft tissues.[8] It has an affinity for hemoglobin and melanin, therefore it is more efficient and better equipped to address deeper soft tissue problems. Since the diode does not interact with dental hard tissues at reduced power settings, the laser is an excellent soft tissue surgical method, indicated for cutting and coagulating gingival and oral mucosa, and for soft tissue curettage or sulcular debridement. There is little information on the behavior of melanocytes after surgical injury. Spontaneous re-pigmentation has been shown to occur and the mechanism suggested is that the active melanocytes from the adjacent pigmented tissues migrate to treated areas. The large variation in time of re-pigmentation may be related to the technique used and the race of the patient. Re-pigmentation may also be attributed to the melanocytes which are left during surgery as stated by Ginwalla et al. These may become activated and start synthesizing melanin.[8]

Diode lasers have high electrical to optical efficiency and are small lightweight as well as compact, hence portable device as compared to other solid state

and gas lasers (such as Nd:YAG, KTP.YAG, Ho, YAG, argon, erbium family and CO_2).

Conclusion

The diode laser is a minimally invasive,less time consuming and patient comfort treatment option for the elimination of unesthetic gingival melanin pigmentation compared to other conventional surgical methods. In this case report, patients does not experienced any intraoperative or postoperative pain or discomfort. The result was excellent at 3-month follow-up period. There was no evidence of re-pigmentation of the gingiva resulting in improved esthetics.

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"Nanodentistry: A looming cult"

Hemalatha DM[1], Anil Melath[2], Mohammed Feroz T.P.[3], Subair K.[4]

ABSTRACT

Nanotechnology/ Nanodentistry, as the name imply, deals with the procedures where particles of one billionth of a meter size are put to use. It is chiefly established by the size of the particles which are used in treatment. Put to use in interdisciplinary fields of dentistry, does wonders right from Diagnosis, Periodontics, Endodontics and Conservative dentistry etc. Nanoparticles have been used to improve the properties of materials and enhance their efficiency.

Keywords: Nanotechnology, Nanorobots, Nanodentistry, Nanocomposites, dentifrobots.

Introduction

Dentistry has evolved from extracting a tooth for a caries in the past, to level of treating patients at the nano molecular level. This travel of dentistry for its advanced version of NANODENTISTRY has been time consuming yet worth anticipating. The use of nano or one billionth of a meter sized particles or robots in dentistry might be stunning but makes treatment rendered to reach the atomic level where the entire scenario of disease processing and propagation takes place. This concept was given by Robert A. Freitas Jr in 1993.

Use of nanotechnology and nanomaterial based design has invaded diagnostics and treating patients. These molecules or molecular tools have advantages of increased surface area due to their nano particular size and more quantum effects. This has a bottom-up approach, where smaller molecular components are used. Nanodentistry has come into Periodontics, Prosthodontics, Endodontics and Orthodontics.

Diagnostics

Molecular level assessment of disease activity and progression has been proven accurate. Use of nanoparticle in diagnosis has accelerated the level of diagnosing oral cancers in its earlier stage of developments. These technical developments can reduce inter and intra operative diagnostic variations. Nanoscale cantilevers are diagnostic nanobeads incorporated in which bind with molecules of cancer associated cells and makes it easier to detect them. Another mechanics called Quantum dots is a newer nanoscience technology used to bind with proteins of cancer cells and diagnose cancer development early.[1] DNA sequencing has been upgraded by nanotechnology where it can be efficiently done by Nanopores that filter the desired DNA of interest and can be manipulated with ease. Genetic sequencing plays a pivotal role in determining the disease susceptibility. Minor alterations in their sequence when detected can aid in treating patient. Gene alteration can be identified by nano carbon rods called as Nanotubes. These nano diagnostic improve-

[1] Postgraduate student, [2]Principal and HOD, [3,4]Professor, Department of Periodontology, Mahe Institute of Dental Sciences and Hospital, Chalakkara, Mahe-653310. Corresponding Author: Dr. Hemalatha D.M, Email: drhemalatha.uk@gmail.com

ments have exhilarated the diagnostics of clinicians for providing a better treatment for patients.[2]

Periodontics

Periodontics have always been aimed at treating gingivitis and periodontitis which are caused by increase in bacterial load. Apart from mechanical removal of plaque with bacteria, Nanorobots called as Dentifrobots can be used to target periodonto pathogenic bacterias in specific and treat periodontitis. These dentifrobots can also reduce the putrefaction of bacteria and reduce halitosis. Oral Fluid Nano Sensor Tests are done in the nano particular salivary samples to diagnose oral cancers at an early stage.

Lab-on-a-chip method, uses silicone wafers incorporated with nano beads for detecting levels of markers of periodontitis like Interleukin 1 beta, C-Reactive protein and matrix metalloproteiase 8. It acts as a simple, fast diagnostic method of detecting Periodontitis. Nanoparticles reinforced hydroxyapatite crystals are used in bone graft materials with higher regenerative capacity. Drug delivery systems with nanospheres, hollowspheres, incorporated with drugs like Tetracycline, Triclosan have shown high site specificity and sulcular concentration of drug in local drug delivery. Doxycycline 8.5% gel has been proven for preserve the periodontal structures in studies. Dentinal hypersensitivity can be efficiently treated with nano molecule treated toothpastes.[3]

Endodontics and Restorative dentistry

Restorative materials always need a pre requisite of increased compressive strength, durability etc. Nanomaterials infused in the restorative materials have improvised these efficacy of restorative materials. Nanomolecules are being infused in composites, adhesives, glass ionomer cements for better results. Nano-composites have found to have more durability and polishing quality. Nano-adhesives have higher bond strength and more marginal seal. Nano-Light cure Glass ionomer restoratives and varnishes have increased compressive strength and biocompatibility and have antimicrobial activity especially Streptococcus mutans and decreases the bacterial load.[4]

Nano material incorporated endodontic sealers like bioceramic sealers, silicon based sealers and Quaternary Ammonium Polyethyleneimine incorporated endodontic sealers are found to have better handling capacity, physical properties, dimensional stability and ease of delivery into the pulp canals.[1] Pulpal regeneration has become possible with nanotechnology. Scaffolds of collagen I incorporated nano molecules have found to regenerate pulp like tissue and odontoblasts in exfoliated teeth stem cells. Cell growth has found to increase with use of Puramatrix, a nanobiomaterial in a study by Demarco et al.[1]

Prosthodontics

Nanotechnology has enhanced mechanical properties of impression materials. Nano molecules infused impression materials of vinylpolysiloxanes have better flow of impression material, and surface reproducibility of the impression. Nanocomposite filled artificial teeth have been made which are highly smooth with high surface finishing and abrasive strength with antifungal properties and may substitute the normal acrylic denture teeth eventually.[8]

Orthodontics

Nanorobots might be used for inducing tooth movements like tooth rotation and straightening. These nanorobots when used in orthodontics might get access through the gingival sulcus or through the tissues around the cement enamel junction and act on the periodontal structures and cause tooth movement. This treatment with nanorobots might reduce the time consumption in orthodontic tooth movement.[7]

Implants

Success of the implant is always gauged by degree of its osseointegration. To achieve it, implants have always been surface treated by additive and subtractive methods like surface coating, etching and sand blasting. Nanotechnology has nanostructured diamonds incorporated on implant surface for better results. Hydroxyapatite crystals coated implants and nano structured metalloceramic coating on implants have been introduced by nanotechnology to increase the osteogenic activity around the implant.[5]

Future concepts of nanodentistry

Use of nanomolecules and nanorobotics in the field of dentistry is imminent. Nanorobots infused col-

loidal local anesthetic gel might come into use, where signalled local anesthetic gel when injected in the oral mucosa or epithelium might enter the specific site through the capillaries and enter the pulp via dentinal tubules and deactivate the nerves in pulp chamber that innervate the tooth. And once the procedure is completed these nanorobots can be deactivated by the clinician.

In the near future the clinicians might be able to make a new autologous whole tooth in their office and use it for replacement of complete dentition through nanotechnology. They might even naturalise patient's teeth which were restored with restorative materials with nanomolecules and may have a tooth similar to their natural tooth before restorations.

Nanorobotics toothpaste and mouthwashes incorporated with nanotech molecules might come into use. They might be proven have a higher efficiency than normal toothpastes in attaining better oral hygiene as the nanobots are left on the occlusal surfaces to defend oral bacteria. Dental nanorobots might be used to treat dentinal hypersensitivity by specifically blocking the exposed dentinal tubules in particular. Nano needles and nanotweezers might come into use, which will increase the ease of microsurgery. These nano materials and nanorobots might be implausible, but with extended research and ethical approach and adequate safety measures they might make it possible for the common man to attain near perfect oral health possible.

Conclusion

Advances in medical and dental fields are essential and pave way for improved health care management. Nano particles usage might not be in light at present but their need and practice might become inevitable in the near future.

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Piezosurgery in Periodontics

Greeshma Sudhakaran[1], Mahesh Narayanan[2], Shabeer Ahamed[3], Jeethu John Jerry[4], Mohammed Harris[5]

ABSTRACT

In the recent years, piezosurgery has gained a lot of acceptance in the surgical field. In dentistry, most of the specialities, utilize piezosurgery. However, most of its application is found in Periodontics and while implant placement. Piezosurgery is based on ultrasonic micro vibrations in the range 25 to 30 kHz. These microvibrations can selectively cut bone, without damaging soft tissue, or any nerve. This review article, mainly attempts to discuss, the mechanism of action, the overview of piezosurgical equipment and the its potential applications mainly in the field of periodontology and oral implantology.

Keywords: Piezosurgery, Ultrasonics, Periodontics, Dental implants

Introduction

In the past few years, there had been a tremendous advancement in the field of the dental surgery. Traditionally, osseous surgery has been performed by either manual or motor-driven instruments.[1] These instruments produce a lot of heat during bone cutting and require high amount of external copious irrigation. These instruments also exerted considerable pressure in osseous surgeries and hence endangered treatment of fractured and brittle bones.[2] To overcome the limitations of traditional tools, researchers have come up with advanced therapeutic devices which use the principle of ultrasonic microvibrations to make precise and selective cut on the bone in harmony with the surrounding tissues.[2] One of the novel methods to incorporate these properties of ultrasonics is, Piezosurgery. These ultrasonic vibrations are low frequency modulated vibrations at 25 to 30 kHz which selectively cut the bone without damaging adjacent soft tissues in particular with delicate structures such as Schneiderian membrane or a nerve.[2]

Historical background

The term "piezo" originates from the Greek word piezein, and means "to press tight, squeeze".[3] In 1880, the Curie brothers Jacques and Pierre discovered "piezoelectricity". They found that putting pressure on various crystals, ceramics, or bone created electricity.

A year later, Gabriel Lippmann found the converse piezoelectric effect. He demonstrated that if an electric field is applied to a crystal, the material will deform.[4] These effects were further investigated by different scientists, and in 1953 Catuna published an article on the use of ultrasound on hard tissue.[4,5] In the following decades, the application of ultrasonic vibrating technology for cutting mineralized tissue was demonstrated by different work groups.[6-8] One of the groups was McFall et al. They investigated the distinction of healing by comparing rotating instruments with an oscillating scalpel blade. The healing was slightly slower in the oscillating scalpel blade group, but overall no severe complications occurred.[7] Horton et al described that on alveolar bones in dogs,

[1]Postgraduate student, [2]Professor and Head, [3]Professor, [4,5]Reader, Department of Periodontology and Oral Implantology, Malabar Dental College & Research Centre, Edappal, Malappuram, Kerala. Corresponding Author: Dr. Greeshma Sudhakaran E-mail: greeshmasudhakaran89@gmail.com

a smoother surface occurred with rotating instruments in comparison with ultrasound. However, in this publication, the bone regeneration was better using the ultrasound device.[8]

Tomaso Vercellotti an Italian oral surgeon modified conventional ultrasonic technology. In 1997 Mectron and Tomaso Vercellotti developed the idea of piezoelectric bone surgery. The main technological advancement was the adaptation of ultrasound movement for bone cutting. Mectron produced the first prototype device for piezoelectric bone surgery with which the first extraction treatments were performed.[2]

A technical note was published by Torrella et al[9] in 1998, and in 1999 Tomaso Vercellotti introduced the name PIEZOSURGERY® for the new method.[2] In 2000, Vercellotti published the first human clinical study about "piezoelectric bone surgery".[10] It was the first time a case was reported on a split ridge in which an edentulous ridge was split even though the ridge was very narrow. With other cutting instruments, it would not have been possible to keep its integrity.[11] Mectron also developed 2nd generation of the piezosurgery device in 2004 which was more powerful than the previous device. In the year 2009 3rd generation piezosurgery device was introduced.[2]

What is piezosurgery?

Piezosurgery (piezoelectric bone surgery) is a promising, meticulous and soft tissue sparing system for bone cutting, based on ultrasonic microvibrations. It was developed by Italian oral surgeon Tomaso Vercellotti in 1988 to overcome the limits of traditional instrumentation in oral bone surgery by modifying and improving conventional ultrasound technology.[12] Not only is this technique clinically effective, but histological and histomorphometric evidence of wound healing and bone formation in experimental animal models has shown that tissue response is more favourable in piezosurgery than it is in conventional bone-cutting techniques such as diamond or carbide rotary instruments.[13] Shock waves in the fluid environment assist in reducing the levels of bacteria, providing a disinfecting action.[14]

Mechanism of Action

Piezosurgery is based on the piezoelectric effect, first described by Jean and Marie Curie in 1880, which states that certain ceramics and crystals deform when an electric current is passed across them, resulting in oscillations of ultrasonic frequency.[12] The vibrations obtained are amplified and transferred to a vibration tip which, when applied with slight pressure on bone tissue, results in a cavitation phenomenon – a mechanical cutting effect that occurs exclusively on mineralised tissue.[15] The bone-cutting technique of the piezoelectric device works due to the use of microvibrations at a specific ultrasonic frequency modulated by sonic waves.[16] The sonic and ultrasonic frequency (25–30 kHz) is produced by a mechanical shock wave that vibrates in a linear manner. The cutting tip works with a reduced vibration amplitude (horizontal 20–200 μm, vertical 20–60 μm). This allows for the main advantages of this device, which are precise and selective cutting, the avoidance of thermal damage, and safety for the patient.[16] The selective cutting is the result of the limited amplitude. At this amplitude, only mineralized tissue will be cut, because soft tissue requires frequencies of greater than 50 kHz.[17] Therefore, the use of piezoelectric instruments will reduce the risk of nerve damage. The reduction of overheating is explained by the generation of a cavitation effect in the irrigation solution due to the mechanical micromovements at a frequency of approximately 25–30 kHz. This also accounts for reduced bleeding, which means better surgical visibility and increased safety.[16]

Piezoelectric Device

The first model of piezoelectric device was developed by Vercellotti et al., and is generally called as 'Piezosurgery'. Piezoelectric devices typically consist of a handheld device [handpiece], a base unit and a foot pedal/switch which are connected to main power unit. There are different shaped inserts that correspond to different applications that can be screwed into the handpiece. The handpiece is controlled by a foot pedal with settings that can be adjusted on the base unit.[2] Piezosurgery requires sufficient irrigation so the flow rate of the cooling solution must be set to avoid overheating the bone.[12] The device has a holder for the hand piece, and contains irrigation fluids that create an adjustable jet of 0–60 ml/minute through a peristaltic pump. It removes debris from the cutting area and ensures precise cutting. It also maintains a blood-free operating area because of cavitation of the irrigation solution, and gives greater visibility particu-

larly in complex anatomical areas. The control panel of the device consists of only 4 buttons which makes it easy and economical. The speed and the irrigation can be controlled by (-) and (+) buttons present on the control panel. Throughout the procedure there is continuous irrigation flow ensured by internal safety control.[2]

Light handpiece pressure and an integrated saline coolant spray keep the temperature low and the visibility of the surgical site high. To increase cooling effectiveness, the solution should be refrigerated to 4^0C. After prolonged cutting, the handpiece warms up so a short pause may be necessary to allow it to cool. The cooling system is generally less efficient when cutting deep layers of bone because increased pressure on the bone decreases cutting speed, so interrupted cutting is advisable. In the case of a deep osteotomy, the combination of piezosurgery and subsequent use of a chisel is useful.[12]

In use, the handpiece is guided firmly over the bone, but without excessive force. In contrast to conventional microsaws or drills, to which the surgeon must apply a certain degree of pressure, the piezosurgery device needs only minimal pressure, permitting a precise cut. Pressure acts in a clearly counterproductive manner, limiting movement of the instrument tip and generating a significant amount of heat. The sound of the cutting can be used as acoustic feedback for the force to be used. At maximum pressure, when the tip stops moving and only heat is generated, a tone warns that bone damage is imminent so cutting should be stopped immediately. The translation speed, the speed of the tip in contact with bone, has an effect on the cutting power. High-level surgical control is required for piezosurgery, because the strength required to cut bone effectively is far less than that required for a drill or oscillating saw. This different bone cutting principle requires a change of habits from those used in conventional osteotomy and osteoplasty techniques.[12]

The frequency of ultrasonic vibrations(Hz), the level of power(W) and the water spray are three adjustable settings that should be set in accordance with the intended procedure.[2] The frequency is usually set between 25 and 30 kHz. This frequency causes microvibrations of 60– 210 mm amplitude, providing the handpiece with power exceeding 5 W.[12]

A piezosurgery unit is approximately three times as powerful as a conventional ultrasonic dental unit, allowing it to cut highly mineralised cortical bone. Several forms of application (modes) are available. Low mode is useful for apical root canal treatment in dentistry. High mode is useful for cleaning and smoothing bone borders. Boosted mode is most often used in oral and maxillofacial surgery in osteoplasty and osteotomies. In the boosted mode, digital modulation of the oscillation pattern produces alternating high-frequency vibrations, with pauses at frequencies up to 30 Hz; this prevents the insert from impacting bone and thus avoids overheating, while maintaining optimal cutting capacity.[12]

Insert Designs[2]

Fig 1: Piezosurgery unit

Fig 2: Gold and Steel insert tips

The grades of precision, predictability and treatment outcome of any surgical procedure depend upon the armamentarium design and the technique used. Depending upon the need and type of surgery, different insert designs can be used. The size and shape of the inserts as well as the purpose of the same determine the level of power required. For eg: saw shaped insert used to cut highly mineralized bone, uses high level of power.

Sharp Inserts: The sharp edge of the instruments enable gentle and effective cut on the mineralised tissue. They are useful in osteotomy procedures like implant site preparation, osteoplasty and other surgical techniques which require fine and well defined cut. Eg: Design No: OT-7, EX1,OP-3, IM2A and IM3P

Smoothening Inserts: They have diamond surface coating which enables precise and controlled work on bony structures to obtain the final bone shape. These inserts are specifically useful to prepare difficult and delicate structures such as sinus window or access to nerve. Eg: Design no: OT5, OT-1, OT-4 and OP-4

Blunt Inserts: They have blunt, dull and rounded non cutting tip. These tips play wonders in atraumatic elevation of the sinus membrane for grafting procedures.

Insert Tip Color[2]

Insert tips are color coded by either *Gold or steel*. Gold insert tips are used to treat bone. It is obtained by applying titanium nitride coating to improve the surface hardness which further increases longevity of the insert tip. Steel is used to treat soft tissue or delicate structures such as roots of teeth.

Indications[18]

(1) Soft tissue debridement, (2) smoothening of root surfaces, (3) bone grafting, (4) implant site preparation, (5) removing an implant, (6) sinus lifting procedure, (7) retrograde root canal preparation, (8) apicectomy, (9) cystectomy, (10) extraction of ankylozed teeth, and (11) orthodontic surgeries

Contraindications[18]

No absolute contraindications

(1) Cardiopathy, (2) patients with uncontrolled diabetes mellitus, (3) patient receiving radiotherapy, (4) patients with metal/ceramic crowns, (5) patients with pacemakers.

Applications of Piezosurgery[2]

The application of piezosurgery in medical fraternity has already been established. It has been used in number of surgical procedures like rhinoplasty, orthopaedic and wrist surgery, mastoidectomy, facial, neurosurgery, traumatology, opthalmology, head and neck surgery as well as plastic and reconstructive surgery.

The dental applications of piezosurgery can be categorised owing to different specialities:

Oral and Maxillofacial Surgery: Piezosurgery has a wide role in oral and maxillofacial surgical procedures. Piezosurgery can be very easily and successfully used in cases which require meticulous handling of delicate structures like soft tissues, piece of a tooth; impacted teeth which is close to anatomical structures. Piezosurgery has been effectively used in atraumatic tooth extraction, enucleation of cyst and tumour, sinus lift procedure, alveolar ridge expansion, ridge augmentation, bone harvesting (Chips and blocks), dentoalveolar surgery, atraumatic dissection of sinus mucosa, alveolar distraction osteogenesis, jaw resection, TMJ ankylosis/ resection. During tooth extraction vigorous movements produced by traditional forceps causes forceful tearing of Sharpey's fibres away from the bundle bone surrounding the socket. This causes disruption of blood supply and trauma to the extraction socket which in turn delays healing. Piezosurgery has been used in this regard to obtain atraumatic extraction which results in faster healing and better recovery. Ultrasonic vibrating 'Syndesmotomes' are recently developed tips for tooth and root extraction. The tip is inserted through gingival sulcus between the space occupied by periodontal ligament between the root and the socket. The periodontal fibres are cut upto or greater than 10mm. Thus when the most apical fibres are severed, the coronal portion is not submitted to a violent 'rip'. Therefore, in this way nearly atraumatic extraction can be achieved.

Endodontics: Hemisection, root amputation, apical resection and endodontic treatment can be easily performed with the help of piezosurgery.

Orthodontics: Osteotomy, corticotomy and orthodontic microsurgery can be successfully done

with the help of piezosurgery.

Periodontology:[1]

The removal of supra and subgingival calculus deposits and stains from teeth, periodontal pocket lavage with simultaneous ultrasonic tip movement, scaling, root planning and crown lengthening, periodontal ostectomy and osteoplasty procedures requires careful removal of small quantities of bone adjacent to exposed root surfaces to avoid damaging the tooth surface. The piezosurgery device is used to develop positive, physiologic architecture of bone support of the involved teeth. The piezosurgery device can be used for soft-tissue debridement to remove the secondary flap after incision through retained periosteum. By changing to a thin, tapered tip and altering the power setting, the piezosurgery device can be used to debride the field of residual soft tissue and for root surface scaling to ensure thorough removal of calculus. Osteoplasty and ostectomy is performed using the piezosurgery device to create positive architecture for pocket elimination surgery. The device allows for precise removal of bone, with minimal risk of injury to underlying root surfaces. Final smoothing of root surfaces and bony margins using a specific ultrasonic insert, PP1, creates a clean field, with ideal bony architecture ready for flap closure. The piezosurgery device is used in bone grafting of an infrabony periodontal defect. Autogenous bone can be readily harvested from adjacent sites with minimal trauma and therefore minimal postoperative effects. Implant site preparation, implant removal and bone harvesting, bone grafting and sinus lifts can be done with much ease and less soft tissue trauma.

Implantology[11]

Preparation of the implant site: The piezoelectric device can be used for different clinical applications in implantology. In healthy bony conditions, it can be employed for the preparation of the implant site. By the use of a special tip, which allows for drilling of a precise implant hole, thermal and mechanical damage to the bone will be reduced.

In 2007, Preti et al assessed the difference between the use of piezosurgery and a conventional drill in regard to the neo-osteogenesis and inflammatory reaction after implant-site preparation. They discovered that more newly formed bone with an increased amount of osteoblasts was visible on the piezoelectric implant site during the early phase (7–14 days). They investigated the following factors in detail: BMP-4, TGF-β2, TNFα, IL-1β, and IL-10. During this early period, BMP-4, TGF-β2, and IL-10 were increased in the piezoelectric group, while IL-1β and TNFα were not. In conclusion, the piezoelectric device stimulated peri-implant osteogenesis, and a reduction of proinflammatory cytokines.[19]

Stübinger et al reported similar results for implant-site preparation. Their pelvic sheep model revealed good biological and biomechanical results.[20]

da Silva Neto et al conducted a prospective study design with 30 patients (bilateral edentulous areas in the maxillary premolar region) who received dental implants using either conventional drilling or piezoelectric tips. Resonance-frequency analysis was used to evaluate the implant-stability quotient in sites prepared by either conventional drilling or piezoelectric tips, showing significant increases in quotient values for the piezosurgery group. Therefore, the stability of implants placed using the piezoelectric method was greater than that of implants placed using the conventional technique.[21]

Sinus-floor elevation In edentulous patients with insufficient bone volume and therefore reduced height of the alveolar crest, a sinus-floor elevation is often the most suitable solution to prepare a sufficient donor site for implant insertion. The surgical procedure includes the removal of a bony window of the anterior sinus maxillary wall. A precise cutting device that does not perforate the Schneiderian membrane is preferable to conventional methods. The perforation of the Schneiderian membrane can occur during the removal of the bony window and during the elevation itself. If a perforation occurs and bone grafting is completed, there is a risk for an inflammatory complication, which can necessitate further surgical procedures, including revision of the maxillary sinus.

Al-Dajani found that a perforation of the Schneiderian membrane doubles the risk for the incidence of sinusitis or infection.[22] Therefore, it is of great importance that any perforation should be avoided.

Seoane et al showed that the use of the piezoelectric device reduces the frequency of membrane perforation among surgeons with limited experience.[23] Specific tips can even decrease the risk of accidental

or iatrogenic perforations.

Vercellotti et al published a surgical protocol using piezoelectric surgery showing a clear reduction (5%) of membrane perforation. In comparison, the prevalence with rotary instrumentation varies between 5% and 56%.[24]

Another clear advantage is the thin cut of the piezoelectric device. Sohn et al showed that the replacement of the bony lateral window into the former defect is possible when using the piezoelectric device.[25]

Furthermore, another striking advantage of piezoelectric surgery is its use during the same surgical session for harvesting bone. Stacchi et al published a scraping–pulling fashion, in which the gained bone chips can then be used for the augmentation, or they can be mixed with various nonautologous materials and placed in the sinus.[26]

Bone grafting:

Dental implants are only possible if sufficient residual bone volume is available. Different techniques for ridge augmentation have been published and proven to be very sufficient.

Autogenous bone grafts from the chin or the ramus are the most common choices if only a limited amount of bone is needed. For larger bone volumes, other donor sites, such as the iliac crest, have to be considered. Bone grafts from the jaw region show good osteogenic properties, little resorption, and thus stable conditions.

Mouraret et al compared the piezoelectric device with a conventional bur in an in vivo mouse model. Osteotomies performed with the piezoelectric device revealed greater osteocyte viability and reduced cell death. With the piezoelectric device, bone grafts exhibited greater short-term cell viability and showed slightly more new bone deposition and bone remodeling.[27]

By use of the piezoelectric device, precise cutting of the graft is easily possible. Piezosurgery requires much less hand pressure than traditional rotary instruments.[28] The shape of the graft can be accurately removed from the donor site, and donor-site morbidity can be kept as low as possible. Majewski investigated the possibility of harvesting individual bone blocks with an individual piezoelectric cut design.[29] This also enables surgeons to remove grafts from regions that are more difficult to reach, eg, the zygomaticomaxillary region or the lateral wall of the maxillary sinus.[30,31]

Anitua et al used an onlay bone graft from the lateral wall of the maxillary sinus for augmentation.[31] This is a good example indicating that the use of a piezoelectric device is not difficult. It is a safe method (preventing soft-tissue and nerve damage) with minimal surgical morbidity.

Altiparmak et al recently evaluated donor-site morbidity following bone harvesting with piezoelectric and/or conventional surgical techniques. They investigated the ramus and symphysis as donor sites. They found that temporary paresthesia in the mucosa was significantly higher in the symphysis group than in the ramus group (P=0.004), and they showed that temporary skin and mucosa paresthesia was lower (P=0.006 and P=0.001) in the piezoelectric group in comparison to in the conventional group. Importantly, no permanent paresthesia of any region of the skin occurred in either donor-site group.[32]

Another aspect is the removal of the graft itself. If it is performed with a conventional bur or saw, normally a chisel has to be used to remove the graft. By using a hammer and chisel, the risk of damaging teeth roots and soft-tissue structures increases. Therefore, in this regard, the use of the piezoelectric device is a safer option, because movement of the patient can lead to iatrogenic slipping and serious complications, even damage of the inferior alveolar nerve.

Edentulous ridge splitting: In insufficient width of the alveolar ridge, the edentulous ridge-splitting technique can be applied. For this procedure, the lingual plate is separated from the buccal plate of the edentulous ridge. Because bland tips are available, the procedure is very safe when using the piezoelectric device, even if the inferior alveolar nerve is accidentally touched. In the available space, the implant will be inserted. Edentulous ridge splitting is possible with conventional instruments. But the piezoelectric device showed a different dimension. Bone separation using the piezoelectric device is even possible in difficult bony situations, due to the exact and well-defined cutting abilities without macrovibrations.

Lateralization of the inferior alveolar nerve: To keep the inferior alveolar nerve intact is essential for the patient's quality of life. The localization of the inferior alveolar nerve can vary distinctively in the edentulous mandible. It is quite essential to perform the oste-

otomies with a tool that reduces the risk of nerve damage. This is possible with the piezoelectric device, because the shape of the tip, surgical control, and the cavitation effect support the surgeon in interventions close to the inferior alveolar nerve. This accounts for the removal of deeply impacted wisdom teeth, which are often located close to the inferior alveolar nerve, as well as for the lateralization of the inferior alveolar nerve. This can be achieved by performing cuts with the piezoelectric device, so that the cortical lateral bone lid is replaceable over the neurovascular bundle. This procedure protects the nerve structure after nerve retraction and transposition.[16] In situations where nerve contact cannot be avoided, Salami et al reported that the negative side effects are much higher if a rotating instrument comes into contact with the nerve.[33]

Advantages of Piezosurgery[12]

Piezosurgery was invented for safely performing sinus lift operations, but new indications are still appearing. The device is generally useful in cases in which bone needs to be cut close to important soft tissues such as nerves, vessels, Schneiderian membrane and dura mater, where mechanical or thermal injury must be avoided. Schaeren et al. have shown that direct exposure of a nerve to piezosurgery, even in worst-case scenarios, does not dissect the nerve but only induces some structural or functional damage. In most cases the nerve is able to regenerate with the perineural sheath intact, in contrast to using a conventional drill or oscillating saw.[34] They also observed that the extent of damage was significantly higher with the application of increased force on the nerve by the device, but not by activation of ultrasonic vibration. This feature makes piezosurgery a promising tool for performing osteotomy close to the nerve.

In contrast to a conventional microsaw, where blood is moved in and out of the cutting area and visibility is decreased, the operative field in piezosurgery remains almost free of blood during the cutting procedure. The reason lies in the cavitation effect created by the cooling fluid distribution and by the type of vibration the instrument generates, in which the blood is essentially washed away, leading to ideal visibility in the operative field. Bleeding from the surrounding soft tissues, as well as the total amount of blood loss, is significantly reduced.

In osteotomies and bone biopsies, it is possible to place the cut at exactly the desired location on the bony surface. The main source of soft tissue damage during conventional bone drilling or sawing is the greater necessity of rotational and torsional power, inadvertently applied close to soft tissue, needed to remove the dense, mineralised tissue. Microscopic examination of bone fragments obtained during piezosurgery showed no signs of the coagulative necrosis and viable cells typically found when using low-power ultrasonic devices and classical drills. Tooth vitality is also protected. Piezosurgery virtually eliminates the need for the chisel.[35]

Piezosurgery produces less vibration and noise because it uses microvibrations, in contrast to the macrovibrations and extreme noise that occur with a conventional surgical saw or bur. Microvibration and reduced noise minimise a patient's psychological stress and fear during osteotomy under local anaesthesia.[36]

Piezosurgery enables meticulous preparation of small bone pieces, such as during periodontal surgical procedures, facilitating the removal of small quantities of bone adjacent to exposed root surfaces in order to avoid damaging the tooth surface. It permits inflammatory tissue removal, root surface debridement and root planing.[37]

Piezosurgery is targeted mainly at bone removal and soft tissue protection, but the modified setting can be used for excision of soft tissue lesions, a feature useful in children.

Limitations[18]

- Adequate dexterity and gentle touch is required for this type of procedure with a different learning curve.
- Increase in working pressure above a certain limit impedes the vibrations of insert, transforming the energy into heat. Thus, the most effective way is to use piezosurgery hand piece with higher speed and a lower pressure.
- Increase in operative time compared to traditional cutting instrument.
- Difficulties encountered in deeper osteotomies sites because lack of insert of appropriate length and thickness to avoid the increasing pressure of the hand preventing microvibration of the insert.

- Inserts get worn away very rapidly, and hence, it is recommended not to go beyond ten uses in bone surgery because it may break or cause damage to tissues by uncontrolled heat.
- Not cost effective.

Conclusion

Piezosurgery is an elegant bone-cutting modality with a rapidly increasing number of indications in different surgical fields. The main advantages of piezosurgery include soft tissue protection, optimal visibility in the surgical field, decreased blood loss, less vibration and noise, increased comfort for the patient and protection of tooth structures. Although increased operating time was anticipated initially, there is now sufficient evidence to conclude that this type of surgery has the potential to decrease the total operating time to the point where it will be similar or lower than that of standard procedures. Many features of piezosurgery need improvement, for example, the cooling system when preparation is performed in deep bone structures and a system to indicate the proximity of the instrument tip to an important anatomical structure, soft tissue or tooth.

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JSPIK

Osseodensification- A Review

Lakshmi Devi S[1], Mahesh Narayanan[2], Shabeer Ahamed[3], Jeethu John Jerry[4], Mohammed Haris[5]

ABSTRACT

Successful osseointegration is a prerequisite for functional dental implants. The implant mechanical stability at the time of surgery, known as primary stability, is a crucial factor to achieve implant osseointegration. In order to achieve good bone to implant contact and good primary stability, it is essential to have sufficient bone bulk and density at the implant site. Standard drill designs used in dental implantology are made to excavate bone to create room for implant placement. A new osteotomy preparation technique, osseodensification was introduced that uses special burs for bone preservation to create a layer of compacted bone along the surface of osteotomy. This relatively new concept has been proposed to help in better osteotomy preparation, bone densification, and indirect sinus lift and also achieve bone expansion at different sites of varying bone densities.

Keywords: bone compaction, primary stability, osseodensification, osteotomy.

Introduction

Primary stability, defined as the biometric stability immediately after implant insertion, is a critical factor that determines the long-term success of dental implants.[1] It plays an important role in successful osseointegration of dental implants and the lack of immediate stability can lead to progressive mobility of the device and its subsequent loss.[2] In other words, primary stability is the absence of mobility in the bone bed after the implant has been placed.[3] The key factors in enhancing implant primary stability are bone density,[4,5] surgical protocol,[6] and implant thread type and geometry.[7] During osteotomy preparation, the maintenance and preservation of bone leads to enhanced primary mechanical stability enhanced Bone to Implant Contact (BIC), thereby enhancing the implant secondary stability.[8] The bone condensing technique has been suggested to enhance the primary stability of dental implants by increasing the bone density.[3]

Osseodensification (OD) is a method of biomechanical bone preparation performed for dental implant placement. The procedure is characterized by low plastic deformation of bone that is created by rolling and sliding contact using a densifying bur that is fluted such that it densifies the bone with minimal heat elevation.[9] Osseodensification was introduced and developed by Salah Huwais in 2013.[10]

The theory behind this technique is that drill designing allows the creation of an environment that increases the initial primary stability through densification of the osteotomy site walls by means of non-subtractive drilling. The rationale for the utilization of this process is that densification of the bone that will immediately be in contact to the endosteal device will not only result in higher degrees of primary stability due to physical interlocking (higher degrees of contact) between the bone and the device, but also in faster new bone growth formation due to osteoblasts nucleating on instrumented bone that is in close proximity with the implant.[11]

Design of osseodensification burs

Huwais S goal was to create a new instrument and procedure to maintain healthy bone while preparing

[1]Post Graduate Student, [2]Professor and Head, [3,4,5] Reader, Dept. of Periodontics, Malabar Dental College And Research Centre, Edappal, Malappuram, Kerala. Corresponding Author: Dr. Lakshmi Devi S., E-Mail: laxmi_sathia@yahoo.co.in

osteotomies rather than remove it, led to the concept of OD and creation of densah bur.[10,12]

Osseodensification burs unlike traditional osteotomy, does not excavate bone but simultaneously compacts and autografts the particulate bone in an outward direction to create the osteotomy, thereby preserving vital bone tissue. These burs have a large negative rake angle, which work as non-cutting edges to increase the density of the bone as they expand an osteotomy. These densifying burs are designed to have four or more lands and flutes that smoothly compact the bone and a cutting chisel edge and tapered shank, so that as they enter deeper into the osteotomy they have a progressively increasing diameter that controls the expansion process. These burs are used with a standard surgical engine and can densify bone by rotating in non-cutting direction or drill bone by rotating in the cutting direction. (at 800 to 1200 rpm) [13]

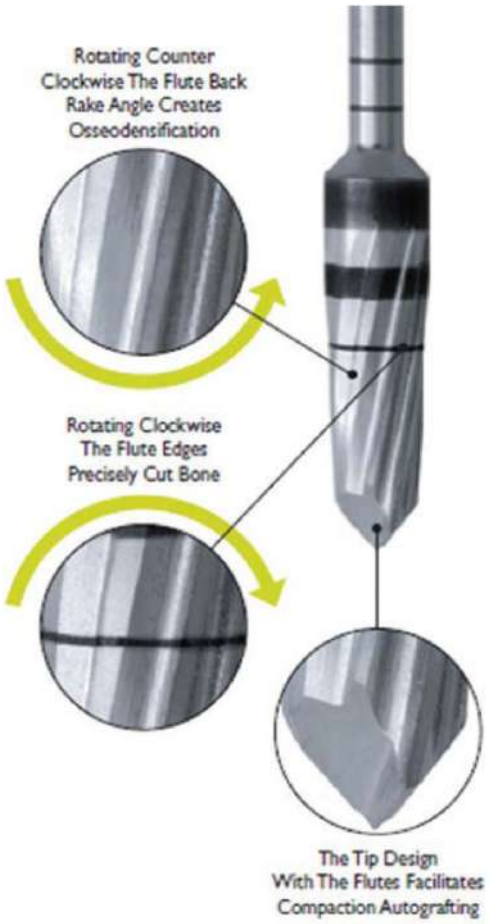

Fig 1: Role of densification drills

In this method bone compaction is done through the application of controlled deformation due to rolling and sliding contact along the inner surface of the osteotomy with the rotating lands of the densifying bur. The bone deformation occurs through viscoelastic and plastic mechanisms when the load is controlled beneath the ultimate strength of bone. Copious amounts of irrigation fluid during this procedure provide lubrication between the bur and bone surfaces and eliminate overheating. A bouncing motion of the bur in and out of the osteotomy will induce a pressure wave ahead of the point of contact. The irrigation fluid that is then often forced into the osteotomy may also facilitate autografting of bone particles along the inner surface of the osteotomy. The autografting supplements the plastic bone compaction to further densify the inner walls of the osteotome.[13]

Conventional drill versus osseodensification

Standard drill designs used in dental implantology are made to excavate bone to create room for implant placement. They cut away bone effectively but typically do not produce a precise circumferential osteotomy. Osteotomies, therefore, become elongated and elliptical due to the imprecise cutting of the drills. This leads to a reduction of torque during implant insertion, leading to poor primary stability and contributing to the potential for no integration of implant. Osteotomies drilled into narrow bone locations may produce dehiscence, buccally or lingually, which also reduces primary stability and will require an additional bone grafting procedure adding cost and healing time to treatment.[14] When standard drills extract enough bone to let strains in the remaining bone to reach or exceed the bone micro-damage (MDX) threshold, the bone-remodelling unit (BMU) needs more than 3 months to repair the damaged area, so maintaining bone bulk will enhance healing and shorten the healing period.[15] Unlike traditional bone drilling technologies, osseodensification does not excavate bone tissue. Rather, it preserves bone bulk, so bone tissue is simultaneously compacted and autografted in an outwardly expanding direction to form the osteotomy. When the densifying bur is rotated at high speed in a reversed, non-cutting direction with steady external irrigation (Densifying Mode), a dense compacted layer of bone tissue is formed along the walls and base of the osteotomy[14] similar to the lamina dura found around teeth.[16]

In contrast to the conventional drilling process, which uses a positive rake angle to extract a small thickness of material with the passing of each flute creating an osteotomy with no bone residue remaining in the hole, the osseodensification drilling process begins with the creation of an osteotomy using a tapered, multifluted bur drill. This procedure utilizes four tapered flutes at a negative rake angle to create a layer of compact, dense bone surrounding the wall of the osteotomy. The densifying bur presents a cutting chisel and tapered shank allowing it to progressively increase the diameter as it is moved deeper into the bone site, which controls the expansion process. The expansion occurs at high speed and can operate in both counter clockwise (CCW) or clockwise (CW) cutting directions, where the former more efficiently exerts the densification process than the later and thus are respectively indicated for low and high density bones.[11]

OD osteotomy diameters were found to be smaller than conventional osteotomies prepared with the same burs due to the springy nature and elastic strain of bone.[9]

Discussion

Achieving primary stability is very important for establishing osseointegration. High primary implant stability is critical in immediate loading protocols, and it was reported that an implant micromotion above 50–100 um potentiated peri-implant bone resorption or implant failures.[17] In 2017, Salah Huwais confirmed that osseous densification technique would increase the primary stability, bone mineral density and percentage of bone at implant surface compared with drilling. By preserving the bulk bone, the healing process is accelerated due to the bone matrix cells, and biochemicals that are maintained in situ and auto grafted along the surface of the osteotomy site.[13]

The success of a dental implant procedure is influenced considerably by the quality and quantity of the available bone. Higher rates of implant failure have been noted in implants placed in poor bone density. This is primarily because of the lower primary stability noted in the implants placed in low bone density. Decreased primary stability may eventually result in impaired secondary stability, that is, osseointegration.[18] Moreover, in areas of low bone density, such as maxillary posterior region, the insufficient bone available could affect the histomorphometric parameters such as bone-to-implant contact percentage (%BIC) and Bone volume percentage (%BV) negatively, thereby affecting primary and secondary implant stability.[9]

The implant primary stability is the direct result of the insertion torque of the implant. An insertion torque of ≥25 Ncm is sufficient for a successful implant placement.[19] However, in case of immediate loading of an implant, an insertion torque of at least 32 Ncm is required which may escalate to 45 Ncm in areas of relatively lower bone density. Thus, in areas of relatively lesser bone density, osseous densification of the osteotomy site would greatly benefit and improve the long term implant success.[18]

A study by Lahens et. al in 2016 revealed high values of insertion torque for osseodensification than regular drilling, regardless of implant macrogeometry. A significantly higher bone-to-implant contact (BIC) for both osseodensification techniques was observed compared to regular drilling.[11] Oliveira et al. reported an increased insertion torque when osseodensification drilling was used in low-density bone.[20] Trisi et al. in in vivo study found increase the %BV around dental implants inserted in low-density bone with osseodensification. A significant increase in insertion torque and a concomitant reduction in micromotion was noted with an increase in bone density values.[5] Lopez CD et al., in their study assessed the biomechanical and histological effects of OD surgical instrumentation in a spine model animal study and concluded that this technique can potentially improve the safety and success rates of bony drilling at all sites of low bone density and limited bone volume.[21]

Osseodensification can alter ridge dimensions and allow for ridge expansion. Koutouzis et al. in their study reported greater expansion at the crest in narrow ridges with adequate trabecular bone volume and the expanded ridge allowed for implant placement in native bone with sufficient primary stability and potentially reduced the need for independent bone augmentation surgery. Alveolar ridge expansion by osseodensification in sites with cortical type I bone or in sites with a limited volume of trabecular bone as well as in a resorbed ridge site that is equally thin at the crest and the base may produce a higher risk of bone overstraining and microfractures.[22]

The osseous densification to elevate sinus floor

have also been reported in the literature. Densifying burs are capable of bone instrumentation in a counter clockwise motion. Hence, irrigation is optimised throughout the osteotomy site and irrigation solution is constantly present at the apical end of the osteotomy. Therefore, once the sinus floor is penetrated by the non- excavating bone compaction drilling process, irrigation solution and autogenous bone chips perform a hydraulic detachment of the sinus membrane and subsequent elevation.[23]

Conclusion

Achieving high primary implant stability is of utmost importance for the establishment of osseointegration. Osseodensification is a recently developed bone preserving osteotomy technique that enhances bone density around implants. It creates an autograft layer of condensed bone at the periphery of the implant bed by the aid of specially designed burs rotating in a clockwise and anti-clockwise direction. It helped improve bone density and also increased the percent of bone volume and increased bone-to-implant contact, thereby improving the implant stability.

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"Periodontal Treatment during Pregnancy: What can be Done?" – A Review

Dhanusha Sreedharan[1], Anil Melath[2], Mohammed Feroz[3], Subair[4]

ABSTRACT

The maintenance of periodontal health is an important part of a healthy pregnancy. During pregnancy there is a marked change in the hormonal levels leading to significant changes in the oral cavity which increases the likelihood of periodontal disease. Periodontal diseases cause adverse pregnancy outcomes such as pre-term delivery, pre-eclampsia and low birth weight babies. It is a dilemma for the dentist whether periodontal disease can be treated safely during pregnancy. This narrative review gives an idea about the periodontal changes during pregnancy, periodontal treatments that can be safely done during pregnancy and the precautions to be taken while treating pregnant patients with periodontal disease.

Keywords: periodontal disease, periodontitis, pregnancy, treatment

Introduction

Periodontal disease in pregnancy usually starts with dental plaque accumulation and is increased by the action of pregnancy hormones.[1] There is a marked increase in the level of progesterone and estrogen during pregnancy which causes increased vascular permeability resulting in gingival bleeding.[2,3] This condition is known as Pregnancy gingivitis.[4] Studies have shown that progesterone may control and reduce local production of matrix metalloproteinases which explains why pregnancy gingivitis may not necessarily progress to periodontitis. There is also a shift in the subgingival levels of Prevotella intermedia and other gram negative anaerobic micro-organisms during the 2nd trimester leading to bone loss and tooth mobility.[5,6] Another inflammatory lesion associated with pregnancy is Pyogenic Granuloma which is caused due to exaggerated response to irritation caused by dental plaque.[7] Treatment of the pregnant patient has the potential to affect the lives of two individuals (the mother and the foetus), so certain principles must be considered so that it benefits the mother while minimising the risk to the foetus.

Periodontal Changes During Pregnancy

In a study which evaluated the periodontal status of pregnant women at the 1st, 2nd, 3rd trimester and 3 months postpartum, it was found that although plaque levels remained unchanged, the gingival index (GI) was significantly increased during pregnancy.[8] The peak increase was seen at the 3rd trimester and dropped at 3 months postpartum. The response of the periodontium during pregnancy is not usually due to a single mechanism but it is rather multifactorial in nature. The most prominent theories to describe pregnancy repercussion include hormone effects on the subgingival biofilm, the immune system, the vasculature and the specific cells of the periodontium.

Changes in Subgingival microbiota during pregnancy: Qualitative shift of subgingival microbiota during pregnancy increases gingival inflammation. Significant differences in proportions for A. actinomycetemcomitans, P. gingivalis, Prevotella intermedia, Tannarella forsynthia, Camphylobacter rectus, Fusobacterium nucleatum etc was seen in pregnant women than compared to non-pregnant women.

[1]Postgraduate, [2]HOD, [3,4] Professor, Department of Periodontics, Mahe Instiitute of Dental Sciences and Hospital, Mahe. Corresponding Author: Dr Dhanusha Sreedharan, E-mail: dr.dhanushas@gmail.com

Changes in Host Immuno-inflammatory response: According to the immune system theory, immune-modulative changes developed for foetal tolerance would render periodontal tissues more prone to develop gingival inflammation during pregnancy. IL-6 production has been known to decrease during pregnancy due to sex hormone stimulation, thus rendering the gingiva less efficient against bacterial challenge. TNF-α is another pro-inflammatory biomarker which is possibly affected by hormonal variations. In addition, a decrease in the ratio of peripheral T helper cells to T suppressor cells (CD4/CD8) has been reported to occur throughout pregnancy.[9]

Changes in gingival vasculature: Due to the marked increase in the level of progesterone and estrogen during pregnancy, vascular permeability increases resulting in gingival bleeding.2,3 This condition is known as Pregnancy gingivitis. Characteristic of pregnancy gingivitis is that the gingiva is dark red, swollen, smooth and bleeds easily.

Changes in cells of the periodontium: The function of cells in periodontal tissue may be affected by estrogen and progesterone. Sex hormones have shown to directly and indirectly exert influence on cellular proliferation, differentiation and growth in the gingiva. However, the synthesis of collagen remains unaffected by estrogen stimulation.

Microbiology of periodontal disease during pregnancy

A direct relationship between worsening of periodontal disease and pregnancy has been demonstrated in many studies.[3,4,9] Periodontal pockets are a reservoir of oral microbiota. Modifications in oral microbiota may be considered as a potential mechanism for developing periodontal disease during pregnancy. A study reported that the worsening in periodontal disease was associated with the increase of "red complex" bacteria like Porphyromonas gingivalis and Prevotella.[10] However, the proportions of the "red complex" bacteria did not differ during pregnancy, although significant differences were found for all the pathogens after childbirth.[9] A study reported that bacterial loading of Porphyromonas gingivalis and Tannerella forsythia at the 3rd month of pregnancy was associated with worsening in periodontal disease measured by bleeding on probing. Another recent study measured bacteria loading of pregnant women and the relationship with estradiol levels.[11] The results concluded that Campylobacter rectus was higher in pregnant women than in non-pregnant women.[11] This data can be explained considering that Campylobacter rectus loading is directly related to the level of estradiol in pregnant women. Another study has shown that the bacteria,

Table 1: FDA categories of drugs used during pregnancy

Drug Category	Definition	Examples of Drug
A	Adequate well controlled studies in pregnant women failed to demonstrate any risk to foetus	Folic acid, Levothyroxine
B	No evidence of risk in humans; animal studies show risk but human findings do not; or animal findings are negative and no adequate human studies have been performed	Amoxicillin(safe),Paracetamol(safe), Cephalosporins(limited information), Metronidazole(avoid), Clindamycin (with caution), Chlorhexidine
C	Human studies are lacking and animal studies are either lacking or test positive for foetal risk; however, potential benefits may justify the risk	Vancomycin (avoid), Ciprofloxacin (avoid), most of the NSAIDs, Fluconazole, Albuterol
D	Positive evidence of risk; investigational or post-marketing data show risk to the foetus; however, potential benefits may outweigh risks (as with some anti-convulsive medications)	Tetracycline(avoid), Clarithromycin (avoid), Paroxetine, Phenytoin, Lithium
E	Studies on humans and animals show that the medicine when given during pregnancy cause problems in the foetus.	Thalidomide, Isotretinoin

and in particular Fusobacterium nucleatum, originating from the periodontal pocket of pregnant women, cross the placental barrier and can cause acute infections.[5] On the contrary, in another study no differences were noted in Fusobacterium species between pregnant and non-pregnant women.[12]

Periodontal treatment of pregnant patients

A careful medical history of the patient should be recorded and obstetrician should be contacted, if required to discuss the medical and dental status of the patient. Regular oral prophylactic treatments such as scaling and polishing can be performed whenever necessary. Any invasive periodontal procedures should be preferably done during the 2nd trimester of pregnancy as it is considered the safest period for dental treatment. If there is an emergency, dental treatment can be done at any point during pregnancy by taking recommended precautions regarding radiation exposure, operative procedure and medications.

Positioning of the patient: When a pregnant woman is sitting in supine position in the dental chair, the uterus may put pressure on the inferior vena cava, thus reducing the venous return to heart. This results in reduced cardiac output and lead to hypotensive syndrome causing patient to become unconscious. This problem occurs primarily in the 2nd and 3rd trimester as the uterus size increases causing compression of inferior vena cava. To prevent this phenomenon, the level of the head of pregnant woman should always be higher than her feet when lying on the dental chair. The ideal position is the left lateral decubitus position with the right buttock and hip elevated by 15 degrees. A small pillow or folded blanket can be placed under right hip so that the uterus is displaced towards the left side and does not put pressure on the inferior vena cava.[13]

Radiographs during pregnancy: According to guidelines given by National Council on Radiation Protection and Measurements (US NCRP), 50 mSv radiation exposure to developing foetus does not cause any significant congenital defect.[14] However adequate shielding and protective equipment should be used to minimise radiation exposure to the foetus, especially during the 1st trimester when organogenesis takes place.

Use of medications during pregnancy: Higher volume of drug distribution, lower maximum plasma concentration, lower plasma half-life, higher lipid solubility and a higher clearance of drugs is seen in pregnancy. Food and Drug Administration (FDA) has classified various medications into different catego-

Table 2: FDA categories of analgesics used during pregnancy

Analgesics	FDA Category	Consideration for use
Aspirin	C/D, third trimester	Caution; avoid in third trimester
Acetaminophen	B	Can be used safely
Ibuprofen	B/D, third trimester	Caution; avoid in third trimester
Codeine	C	Use with caution; consult with obstetrician
Hydrocodeine	B	Use with caution; consult with obstetrician
Oxycodeine	B	Use with caution; consult with obstetrician
Propoxyphene	C	Use with caution; consult with obstetrician

Table 3: FDA categories of antibiotics used during pregnancy

Antibiotic	FDA Category	Consideration for use
Penicillin	B	Can be used safely
Erythromycin	B	Can be used safely, avoid estolate form
Clindamycin	B	Can be used safely
Cephalosporins	B	Can be used safely
Tetracycline	D	Avoid
Ciprofloxacin	C	Avoid
Metronidazole	B	Avoid; Controversial
Gentamycin	C	Use with caution; consult with obstetrician
Vancomycin	C	Use with caution; consult with obstetrician
Clarithromycin	D	Avoid

ries according to the safety when used in pregnancy (Table:1). Fortunately, there is a small number but a wide variety of drugs that are teratogens (drugs that cause either structural or functional birth defects). The safest antibiotic that can be used during pregnancy is amoxicillin and penicillin V.[15,16] Tetracycline should not be used during pregnancy because studies show that it gets accumulated in foetal dental tissues during calcification resulting in tooth discoloration. Among NSAIDs, paracetamol can be safely prescribed. Obstetricians have discouraged pregnant women from taking analgesic doses of aspirin as it can cause pre-term labour. Ibuprofen, naproxen and ketoprofen in early pregnancy has been associated with increased risk of cardiac septal defects and must be avoided. Tables: 2 and 3 present FDA approved general guidelines for analgesic and antibiotic use during pregnancy.

Use of local anesthetics: Commonly used local anesthetic agents during periodontal non-surgical and surgical procedures include lidocaine (2%) and mepivacaine (3%). FDA has classified anesthetic agents into different categories according to the safety when used during pregnancy (Table:4). Most safely used agents are lidocaine, prilocaine and etidocaine. These agents can be used along with a vasoconstrictor, however the recommended maximum dose during pregnancy is much lower than the maximum recommended dose.

Table 4: FDA categories of local anesthetics used during pregnancy

Local Anesthetic Agent	FDA Category	Consideration for use
Lidocaine 2%	B	Can be used safely
Prilocaine	B	Can be used safely
Etidocaine	B	Can be used safely
Mepivacaine 3%	C	Used only if needed in consultation with obstetrician
Bupivacaine	C	Used only if needed in consultation with obstetrician
Procaine	C	Used only if needed in consultation with obstetrician
Articaine	C	Used only if needed in consultation with obstetrician

The maximum dose for lidocaine is 500mg, prilocaine 600mg and for etidocaine it is 400mg.

Trimester periodontal care during pregnancy

First trimester (conception to 14th week): Organogenesis takes place during the 1st trimester so, elective dental care if possible should be avoided. As pregnant women are more susceptible to periodontal diseases, a complete periodontal screening is recommended. Preventive periodontal therapy is done and home care instructions are given to the patient.

Second trimester (14 to 28 weeks gestation): Organogenesis is completed and therefore the risk to the foetus is low. The early portion of the second trimester is ideal for providing elective dental care. Periodontal debridement aimed at cessation of disease progression is aimed during this period. Pyogenic granuloma can be surgically removed safely during this period and the patient should be advised to maintain a good oral hygiene and use oral irrigation devices at home. However, major elective periodontal surgical procedures should be postponed until after delivery.

Third trimester (29th week until childbirth): Although there is no risk to the foetus during this period, the pregnant mother may experience an increasing level of discomfort. Also, the uterus is very sensitive to external stimuli and the chances of premature delivery exist. During early or mid of third trimester, a periodontal maintenance visit should be scheduled to evaluate periodontal status and provide treatment if required. The dental appointments should be short and appropriate positioning of the patient in dental chair must be taken care of.

Conclusion

Establishing a healthy oral environment is the primary aim in providing dental care to pregnant patients. The dental care professionals must have a basic understanding of the physiologic and microbiologic changes that occurs during pregnancy and the influence of drugs on the patient and foetus. In conclusion, it is important to remember that the treatment is being rendered to two patients: the mother and her foetus. All treatments should be done only after consultation with the patient's obstetrician. It is best to avoid drugs that put a risk to the foetus and periodontal treatments

must be done as comfortable as possible to both the mother as well as the foetus.

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Rapid Prototyping: An emerging era in Periodontal Regeneration

Jeevanandam Vishnusripriya[1], Anil Melath[2], Mohammed Feroz[3], Subair[4]

ABSTRACT

The introduction of Digital treatment planning and execution have made the management of a disorder easier. Three-dimensional printing technologies have evolved rapidly in the recent years and can be used in a wide array of different materials. This technology enables to produce small quantities of customised goods at relatively low cost. Though at present the technology is primarily used to manufacture prototypes and mock-ups, yet several promising applications exist in the production of replacement parts, scaffolds, dental crowns, and artificial limbs. The term 3D printing is used to describe a manufacturing method that builds objects one layer at a time, in a layer by layer manner adding multiple layers to form an object. This process is more correctly described as additive manufacturing and is also referred to as rapid prototyping. 3 D printing technology has the potential to be beneficial to patients and doctors in terms of patient-specific individualised management. This article introduces 3D printing and gives information about the technology behind the working of 3D printers. In concise about the applications and materials used for 3D printed scaffolds for periodontal regeneration.

Key Words: 3D Printing, Patient-Specific, Scaffolds, Regeneration

Introduction

The introduction of digital treatment planning and execution have made the management of a disorder easier. Three-dimensional printing technologies have evolved rapidly in the recent years and can be used in a wide array of different materials. 3D printing enables small quantities of customized goods to be produced at relatively low cost.

3D printing term is used to describe a manufacturing approach that builds objects layer by layer, adding multiple layers to form an object. This process is more correctly described as additive manufacturing and is also referred to as rapid prototyping.[3]

3D printing technology has the potential to be beneficial to patients and doctors in terms of patient-specific individualized management.

Origin and progress of 3D printing

The term "3D printing" was coined in 1995 by Ely Sachs at Massachusetts Institute of Technology, who authored a project of modifying an inkjet printer in such a way that a binding solution was extruded onto a bed of powder, like ink onto paper in inkjet printers

In 1983, Charles Hull was the first person to print a three-dimensional object. When he first described a vat polymerization method, he founded the 3D Systems Corporation and a year later, released the SLA-1 in 1984. He created the first 3D printer that used the technique of stereolithography, as well as the first program for virtualization. In 1999, a patient with cleft palate was treated with the help of 3DP by Dawood A et al.[3]

3D printing process

3D printers work in a manner similar to traditional laser or inkjet printers, rather than using multi-coloured inks, the 3D printer uses a powder or liquid resin that is slowly built from an image on

[1]Postgraduate, [2]HOD, [3,4] Professor, Department of Periodontics, Mahe Institute of Dental Sciences and Hospital, Chalakkara, Palloor, Mahe - 673310, Corresponding Author: Dr Vishnusripriya J., E-mail: vishnusripriya.j@gmail.com

a layer-by-layer basis. All 3D printers use a 3D CAD software which exactly determine how each layer is to be constructed, this is done by measuring thousands of cross sections of each product. The 3D machine dispenses a thin layer of liquid resin which is hardened layer by layer using a computer-controlled ultraviolet laser in the specified cross section pattern. At the end excess resin is removed using chemical bath.

The 3DP process has the following steps:[26]

1. Acquisition of 3D patient model, customised either physical or digital
2. Creating the design STL file
3. 3D Printing
4. Post processing

Acquisition of 3D patient model

Three dimensional models are made either with a Computer-Aided Design (CAD) package, via a 3D scanner, plain digital camera, photogrammetry software and x-ray or tomography images of medicine and dentistry[4]. Image sections are reconstructed with isotropic voxels of 1.25 mm or less. Model accuracy is due to thick section whereas extensive segmentation, STL refinement is required for very thin sections (<0.25 mm)[15]

Creating design STL file

Three dimensional printers don't support the standard DICOM images format instead they accept file of an object with file format of surface in Standard Tessellation Language (STL) which is just a collection of triangles fitting together in a puzzle forming object, necessary adjustment can be made in this file format and can be transferred to a 3D printer.

Three-Dimensional printing

There are at least 18 methods of 3DP and diversified printing materials. Therefore, selection an appropriate 3D printer is challenging. The following parameter are analysed for its use such as:

- Cost effective
- Easy to install
- Colour capability
- Time required to print

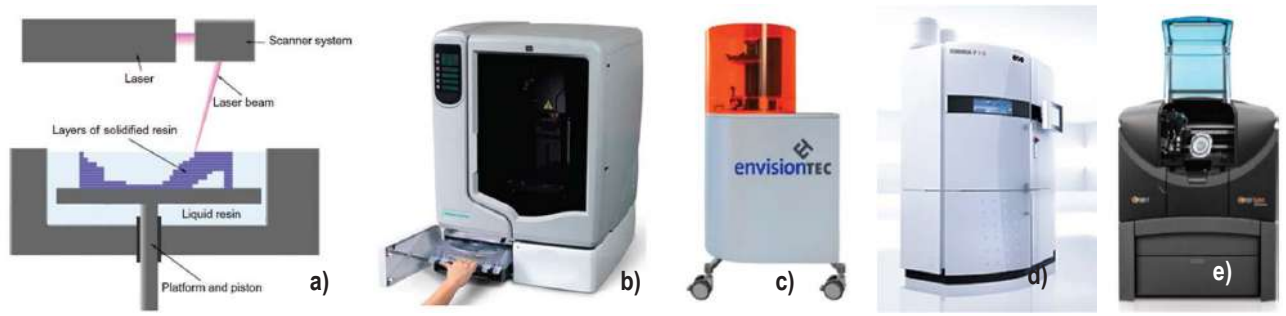

Fig 1: a) Stereolithography Technique b) Printer Inkjet 3D Printer c) Direct Light Processing (DLP) d) SLS 3D Printer e) FDM Technique Printer

Fig 2: FDM Scaffold Specifically Designed to Match the Anatomic Dimension of an Extraction Socket

- Biocompatibility
- Acceptance of large number of materials
- Should provide intended service
- Less technique sensitive
- Accept sterilization

Post processing

An important step after an object has been printed, using most methods is post processing. Due to the layering involved in the processing, the printouts have rough surfaces. Post processing of the printed model includes curing, polishing, cleaning and sterilization, depending on the clinical usages.

Materials used in 3D printers

Several materials are used in 3D printers which vary as per the object to be printed. 3D printing uses such raw materials as plastics, resins, super alloys, such as nickel-based chromium and cobalt chromium; stainless steel; titanium; polymers; and ceramics composite materials and polycaprolactone.

Materials most often used for Periodontal Regeneration are:

1. Polymers and Hydrogels:

Synthetic polymers are probably the class of materials most commonly used for 3D printing in biomedical applications.[25] Hydrogels present remarkable tunability of rheological, mechanical, chemical, and biological properties and high biocompatibility[16]. Nowardays, prepolymerized cell-laden methacrylated gelatin hydrogels is used efficiently for bioprinting.[1]

2. Ceramics:

Ceramic scaffolds are usually composed of calcium and phosphate mineral phases, such as hydroxyapatite[13] or ß-tricalcium phosphate.[23]

In three-dimensional printed ceramic scaffolds, cells tend to quickly populate the scaffold surface, therby establishing close cell–cell interactions and promoting cell proliferation and differentiation. In addition, ceramics have much lower rates of degradation than hydrogels, which allows for prolonged guided tissue remodelling and structural support.[16]

3. Composite Materials:

Printable composites, which are usually in the form of copolymers, polymer– polymer mixtures, or polymer–ceramic mixtures allow for the combination of several advantageous properties of their respective constituents, thus forming interesting candidates for bio inks used in craniofacial regeneration.[21] It can also be classified as rigid, semi rigid, flexible and composite material.

4. Polycaprolactone (PCL):

It is a hydrolytically biodegradable polyester and is easily manufactured into a variety of shapes and porosities with variable mechanical properties and has been the material of choice in multiphasic scaffolds for regeneration of periodontia.[21]

Three-Dimensional printing systems

The 3DP technology used in medicine can be classified based on the technique, the material or the aimed deposition process used. (Table 1)

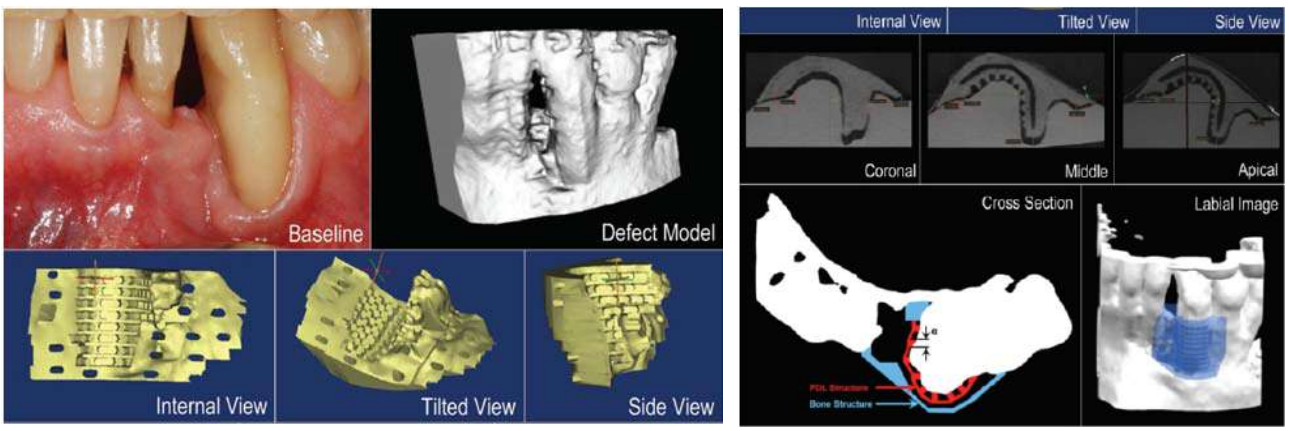

Fig 3: Customized scaffold for peri-osseous defect

Most commonly used technology includes:

1. Vat Photopolymerisation,
2. Material Jetting,
3. Binder Jetting,
4. Material Extrusion,
5. Powder Bed Fusion,
6. Sheet Lamination And
7. Directed Energy Deposition.

I. Vat Photopolymerisation

a. Stereolithography
b. Digital Light Processing
c. Photopolymer Jetting
d. Continuous Liquid Interface Production (CLIP)
e. Multiphoton/Two Photon Polymerisation (MPP/TPP)

II. Material and Binder Jetting

(a) Material Jetting
(b) Aerosol Jet Printing
(c) Powder Binding Technology

III. Three-Dimensional Material Extrusion

a) Fused Deposition Modelling (FDM)

IV. Powder Bed Fusion Processes

(a) Selective Laser Sintering
(b) Direct Metal Laser Sintering

V. Sheet Lamination or Laminated Object Manufacturing

VI. Direct Energy Deposition

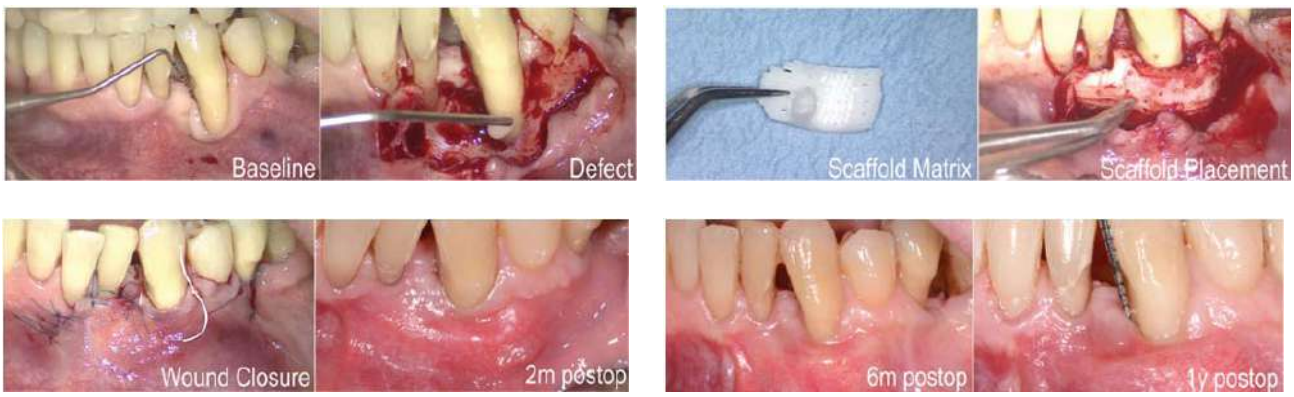

Fig 4: Clinical outcome of scaffold implantation

Fig 5: Post-operative exposure and retrieved scaffold matrix

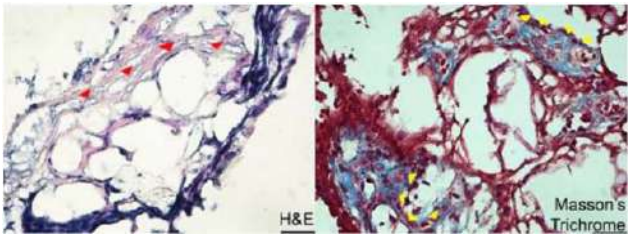

Fig 6: Histologic analysis of the retrieved scaffold matrix

Direct 3 D printing

This technique can arrange multiple cell type, deposit extra cellular matrix, and provide fine-tuned control over bioactive molecules. To date, peptides, proteins, DNA plasmids, and living cells have been printed.[2] 3D printing has also been used to produce a 3D cell culture model for generating ECM on scaffolds[20].

Indirect 3 D printing

The rapid prototyping method can be also used for indirect printing, the printing of a mold that is then cast with the final polymer. With this method, a computed tomography scan of the patient's defect can act as a template for making a 3-Dimensional mold. This mold can later be used for making a scaffold for gene therapy and a growth factor delivery system. Park and co-workers[19,20] designed a 3D wax mold to produce a fiberguiding scaffold to improve integration of PDL fibers into mineralized tissues. In a randomized controlled clinical trial, the use of prefabricated 3D polycaprolactone (PCL) scaffolds in post extraction sockets resulted in normal bone healing and better maintenance of the alveolar ridge as compared with extraction sockets without scaffolds.[7]

Hydrogel Scaffolds

Additionally, 3D plotting is a technique to make soft tissue scaffolds, such as hydrogels, with direct incorporation of cells while retaining their normal activity.[2] A potential limitation of the hydrogel as a scaffold includes inhibition of cell-to-cell interactions, which may influence cell signalling.

3D printing with live cells

3D printing of living cells, either in cell aggregates or seeded onto 3D printed scaffolds may enhance cell signalling and promote tissue formation. Scaffold free approach is defined as layer-by-layer additive biomanufacturing and is a technique with the potential to remove the need for a scaffold.[16] Mini-tissue-based approach is a technique in which tissue spheroids are used as building blocks that fuse to form a tissue. Self-assembled vascular spheroids can form a branched vascular system within a 3D construct, thereby providing blood supply to all parts of newly forming tissue.[14] Interestingly, recent studies report on the use of 3DP to build complex tissues, such as constructing periodontium-like tissue.[11] A 3DP bioresorbable scaffold has been used for periodontal repair.[6] 3DP also has the potential to make complex, patient-specific constructs such as temporomandibular joints.[2]

Emerging concepts of Tissue Engineering

In Periodontology novel methodology are evolving for periodontal regeneration. These include the use of advanced biomedical imaging such as cone beam computed tomography used for pathology visualization, Implant placement and to visualize topography of bone. Cone beam computed tomography technology offers high resolution and three-dimensional imaging of bony topologies that allow the development of image-based scaffolds that can be personalized to fit precise defect morphologies around teeth.[6] The image-based scaffolds can be made via several rapid prototyping techniques to manufacture polymeric or ceramic scaffolds. For example, Rapid Prototyping has been utilized to make surgical guides and few first-generation regenerative scaffolds for clinical use. These scaffolding technologies can be used in combination with either biologics or cell therapies to create bioactive scaffolding systems for tissue repair.[6]

Rapid prototyping applied to periodontal Scaffold design and fabrication

The design of scaffolds, mimic the complex periodontal shape and organization, which is significantly challenging in Periodontal regeneration. Adoption and long-term success of these Rapid prototyping strategies greatly rely on the biomaterials being used. Regarding periodontal regeneration, the most commonly used materials for restoring and/or replacing lost oral tissues are ceramics and polymers.[27]

Ceramic biomaterials such as calcium phosphate (CaP), calcium sulfate (CS), and bioactive glass (BG) are ideal for hard-tissue engineering and rehabilitation of the lost function as they are similar in composition to bone mineral, the stimulating effects on cell proliferation and differentiation, and their relatively low degradation rate, the latter specifically facilitating prolonged guided tissue remodelling and structural support. Despite these advantages, the brittleness and low ductility need to be considered when using these materials.[8]

Table 1: 3D printing modalities and materials[3]

Techniques	*Advantages*	*Disadvantages*
Light cured resin		
1- Stereolithography (SLA)		
Light sensitive polymer cured layer by layer by a scanning laser in a vat of liquid polymer. (Figure 1 a)	Rapid fabrication. Able to create complex shapes with high feature resolu¬tion. Lower cost materials if used in bulk.	Only available with light curable liquid polymers. Support materials must be removed. Resin is messy and can cause skin sensitisation, and may be irritant by contact and inhalation. Limited shelf life and vat life. Cannot be heat sterilised. High cost technology.
2- Photojet - Light sensitive polymer is jetted onto a build platform from an inkjet type print-head, and cured layer by layer on an incremen¬taly descending platform. (Figure 1 b)	Relatively fast. High-resolution, high-quality finish possible. Multiple materials available various colours and physi¬cal properties including elastic materials. Lower cost technology.	Tenacious support material can be difficult to remove completetly. Support material may cause skin irritation. Cannot be heat sterilised. High cost materials.
3- DLP (digital light processing) Liquid resin is cured layer by layer by a projector light source. The object is built upside down on an incrementally elevating platform. (Figure 1 c)	Good accuracy, smooth surfaces, relatively fast. Lower cost technology.	Light curable liquid polymers and wax-like materials for casting. Support materials must be removed. Resin is messy and can cause skin sensitisation, and may be irritant by contact Limited shelf life and vat life. Cannot be heat sterilised. Higher cost materials.
Powder binder		
Plaster or cementaceous material set by drops of (coloured) water from 'inkjet' print head.Object built layer by layer in a powder bed, on an incrementaly descending platform.	Lower cost materials and technology. Can print in colour. Un-set material provides support Relatively fast process. Safe materials.	Low resolution. Messy powder. Low strength. Cannot be soaked or heat sterilised.
Sintered powder		
Selective laser sintering (SLS) for polymers. Object built layer by layer in powder bed. Heated build chamberraises temperature of material to just below melting point. Scanning laserthen sinters powder layer by layer in a descending bed.	Range of polymeric materials including nylon, elas¬tomers, and composites. Strong and accuracte parts. Self-supported process. Polymeric materials – commonly nylon may be auto¬claved. Printed object may have full mechanical func¬tionality. Lower cost materials if used in large volume.	Significant infrastructure required, eg. compressed air, climate control. Messy powders. Lower cost in bulk. Inhalation risk. High cost technology. Rough surface.
Selective laser sintering (SLS) - for metals and metal alloys. Also described as selective laser melting (SLM) or direct metal laser sintering (DMLS). Scanning laser sinters metal powder layer by layer in a cold build chamber as the build platform descends. Support structure used to tether objects to build platform. (Figure 1 d)	High strength objects, can control porosity. Variety of materials including titanium, titanium alloys, cobalt chrome, stainless steel. Metal alloy may be recy¬cled. Fine detail possible.	Elaborate infrastructure requirements. Extremely costly technology moderately costly materials. Dust and nanoparticle condensate may be hazardous to health. Explosive risk. Rough surface. Elaborate post-processing is required: Heat treatment to relieve internal stresses in printed objects. Hard to remove support materials. Relatively slow process.
Electron beam melting (EBM, Arcam). Heated build chamber. Powder sintered layer by layer by scanning electron beam on descending build platform.	High temperature process, so no support or heat treat¬ment needed afterwards. High speed. Dense parts with controllled porosity.	Extremely costly technology moderately costly materi¬als. Dust may be hazardous to health. Explosive risk. Rough surface. Less post-processing required. Lower resolution.
Thermoplastic		
Fused deposition modelling (FDM) First 3DP technology, most used in 'home' print¬ers. Thermoplastic material extruded through nozzle onto build platform. (Figure 1 e)	High porosity. Variable mechanical strength. Low - to mid-range cost materials and equipment. Low accuracy in low costequipment. Some materials may be heat sterilised.	Low cost but imited materials - only thermoplastics. Limited shape complexity for biological materials. Support material must be removed.

Applications of 3D printing in periodontology

In dentistry, 3D printing has diverse applicability, has become a promising technology, and has increased possibilities of many new and exciting treatments. It can be widely used to create patient models which can ease in treatment planning for orthodontics and in prosthodontics, crown copings and partial denture frameworks can also be prepared. In periodontology, the complex hierarchical organization of the periodontal tissues requires multiphasic biomaterial constructs which can recapitulate the structural integrity of the bone–ligament interface.[14] Additive biomanufacturing technologies have recently been applied to the field of periodontal regeneration to develop hierarchical scaffolds, mimicking the properties and architectural configuration of the periodontium, which consists of both soft (gingiva and periodontal ligament) and hard (bone and cementum) tissues.[16]

These scaffolds are referred to as multiphasic constructs and they have various compartments recapitulating the original structure of the periodontal complex.[28] Polycaprolactone FDM specifically designed plugs (Figure 2) are used for alveolar ridge preservation with some success providing an alternative to particulate synthetic calcium phosphate or deproteinized xenograft materials.

Three-dimensional printed bioresorbable scaffold for periodontal repair has also been used by Rasperini et al. in the treatment of defects in a patient with aggressive periodontitis. The patient was a 53-year-old healthy male and the treatment was done in order to preserve his dentition. Scaling and root planing were done and two years later he showed signs of periodontal stability with an osseous defect in mandibular left cuspid. A customized scaffold was 3D printed using medicalgrade polycaprolactone to fit the peri osseous defect using a prototype model of the defect from the patient's CBCT Scaffold matrix was placed onto the defect and post- operative follow-up was done. (Figure 3 and 4)

A computer-designed, fiber-guiding scaffold has been desisgned to promote tooth supporting periodontal tissue regeneration and create similar topographies in alveolar crest, horizontal, oblique, and apical fibers of natural periodontal ligaments. Two years later the patient showed signs of periodontal stability with an osseous defect in mandibular left cuspid. Post-operative exposure and retrieval of the scaffold matrix was done. (Figure 5) Histologic analysis of the retrieved scaffold matrix with hematoxylin and eosin (H&E) and Masson's trichrome staining, indicate small islands of new bone formation within a milieu of primarily granulomatous tissue. (Figure 6)

In a recent study conducted by Park et al., two types of scaffolds were compared for periodontal regeneration. A fiber-guiding scaffold was prepared using wax molds and cast to PCL with the help of 3D printer and another salt-leaching scaffold was prepared by using PCL immersed in 25wt/v% polymeric 1, 4-dioxane solution. These scaffolds were used in rats in which osseous fenestration defects were formed. Results showed that customized fiber-guiding scaffolds had a significantly high defect conformation.[18]

Limitations

The theoretical applications of 3D Rapid prototyping in dentistry are endless. There are certain barriers which needs to be addressed so as to use this technology to its full potential. The barriers, limitations and challenges of 3D printing are as follows.[5,12,24]

1. Cost and speed of production is an important limitation;
2. Development and standardisation of new materials;
3. Validation of the mechanical and thermal properties of existing materials and technologies;
4. Time spent in post processing affects the cost effectiveness of the model and reduces its usefulness in cases requiring urgent intervention;
5. Issues related to copyright;
6. Designers and engineer's skill in 3D printer are limited;
7. Lower precision relative to other technologies.

Conclusion

Applications of 3D printing in dentistry are already diverse and it is a promising technological innovation for regenerative periodontology. Three-dimensional imaging, allows more predictability in management of complex interdisciplinary clinical scenarios. These 3D scaffolding technologies can

be used in combination with either biologics or cell therapies to create bioactive scaffolding systems for tissue repair. The limitation in the usage of these cell scaffolds in day-to-day practice is difficulty in getting clearances from regulatory agencies as it involves cells and tissues. Further well-controlled clinical trials are required to prove the efficacy of the Rapid Prototyping scaffolding systems.

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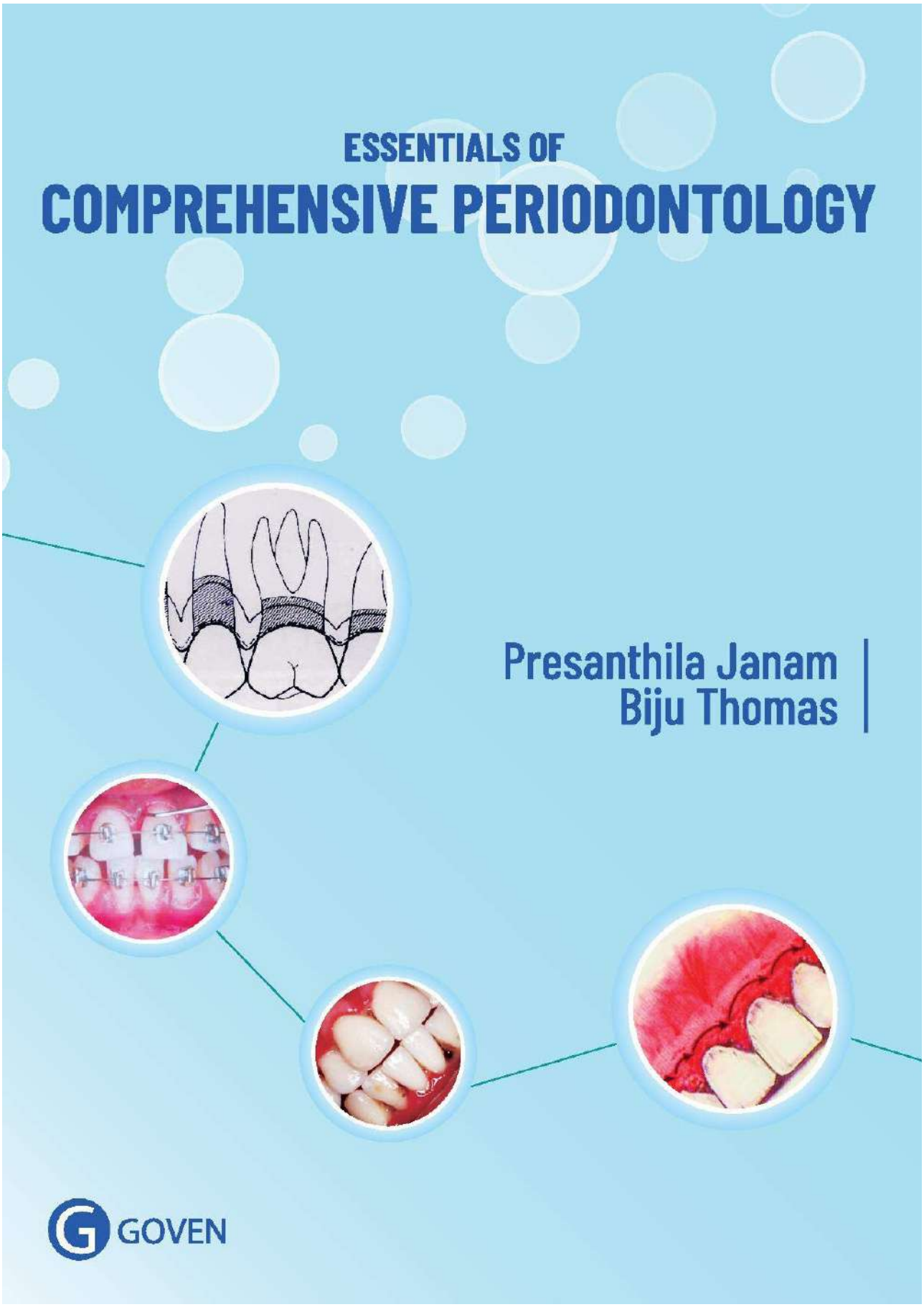

SPIK family congratulates our senior members Dr Prasanthila Janam and Dr Biju Thomas on the release of their Textbook in Periodontics during the 44th National Conference of Indian Society of Periodontology held at Bangalore in November 2019