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Idgah Road, Qazi Para,
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Ph.: +91-1342-359-420

Website & e-mail : http://www.updent.in, updent@gmail.com,

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Editorial

JPDENT

From The Desk of Guest Editor....

Periodontology as a speciality was established in India1959,when post-graduation courses started in this field . It did not gain much respect till 1970's as it was the least researched area of the oral cavity. Since the branch deals with the main supporting structures that hold the tooth in its stabilised zone. From 1970's onward, there was a flooding of research coming in from all parts of the globe and some key concepts were established related to etiology and pathogenesis of the disease which affects nearly 90% of the human population. This ultimately led to the development of novel methods of not only controlling the disease but also a step towards regenerating the lost tissues. There has been a lot of research going in the area of establishing the main cause of the disease. The concepts varied from the bacterial etiology to complex mechanisms involving the host response, risk factors , environmental factors and genetics influencing the course of the disease. The latest concepts about the etiology have placed importance on the inflammatory response of the individual as one of the decisive factors

The categorisation of the disease has also undergone many revisions and more than 10 classifications have been developed. Terms related to the etiology and the rate of progression of the disease were initially divided into two main categories of adult periodontitis and juvenile periodontitis and later on as chronic and aggressive periodontitis. Although this classification was able to identify most of the cases in the population, there was a lot of overlap related to the age of onset, familial aggregation and hallmark features associated with each category. The latest classification developed has discarded both the terms and classified the diseases with degree of disease and bone loss. It has thus simplified the diagnosis and disregarded the individual subjective opinions about the type of disease variations.

There has been a lot of advancements with regard to the development of novel techniques and tools for the prevention of the disease related to the introduction of powered brushes, ionic brushes and sonic brushes and use of mouthwashes with antimicrobial properties.

The non surgical therapy has encompassed some new agents which have been tried in the medical field to treat some chronic illness and have now found some role in the periodontal therapy like host modulating agents .The surgical aspect of the speciality has evolved from some more gross surgeries to refined surgeries and their modifications as applicable to different clinical situations. There has been a lot of refinement in techniques and the tools used to perform different surgical procedures which include lasers, piezosurgery and use of different biomaterials. The use of substitutes has greatly enhanced the outcomes along with less surgical trauma to patients.

Periodontology has undergone a major shift from being a speciality for not only saving, retaining and prolonging the life span of the tooth to an esthetically demanding branch which led to the development of mucogingival surgeries. Further refinement of these procedures and inclusion of many other estheticconcerns were encompassed under the periodontal plastic surgery . This has led to introduction of many procedures which can correct the discrepancy between the gingival margin, attached gingiva and vestibule.

There has been an advent of procedures which involve minimally invasive approach to reduce the pain and healing time.
Inspite of very effective methods to save the teeth, some have to be relegated to extraction because of the long term detrimental effects on the overall functional prognosis on the whole dentition.

The implants have made life easy for patients who have already lost their teeth and they can now enjoy the benefits of fixed prosthesis with improved mastication. Implants over the time has gained a lot of popularity with improvements in the success rate with a lot of new research that is carried out in the past two decades.

The treatment of the diseases of the periimplant tissues also encompasses the latest methods to enhance the survival rate of implants.

Although we have come a long way and are able to treat a majority of periodontal diseases there still remains a lot to be established with accuracy as far as the control of etiological agents are concerned. New research has also confirmed a strong link between the systemic ailments and the oral health conditions. These findings have opened a plethora of agents that have been used to control the chronic inflammatory conditions and have found away to be included in our paraphrenia as periodontitis also qualifies as a chronic inflammatory condition.

There is a lot of scope to carry out research in this field. The immunological aspect of the disease needs a lot of upgradation which may open new avenues for developing novel molecules to intercept the disease at the earlier stages. Microbiological research may open up some new uncultivable organisms which may have a key role in the pathogenesis of the disease and are controllable. There is a scope for developing strategies to retain the active molecules at the site of action for a more prolonged and effective action. The influence of environmental and metabolic influences on the disease can be explored at a greater depth and accordingly the control of such influences can be developed.

The field of Periodontology is a dynamic area which is quite interesting and the new budding dentists can join webinars, attend conferences, present papers and interact with the stalwarts of dentistry to carve a niche for themselves. The advent of internet has opened new avenues to connect with far reaching experts to gain motivation and the zeal to do wonders in this profession.

As rightly quoted by Willement Stone

“Success is achieved and maintained by those who try and keep trying”

Dr Nymphea Pandit
Professor and Head
Past President ISP
Department of Periodontology
D.A.V Dental College and Hospital
Yamunanagar Haryana

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Afzal A. Zaidi
Founder Chairman
Media House, Zaidi Colony, Idgah Road
Near New Era Public School, Qazipara
Bijnor-246701 (U.P.) India
P.: +91-1342-359420, C.: +91-9027637477
updent@gmail.com, www.updent.in

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A CASE REPORT

An Overview of Peri Implantitis

Sandeep Singh Nirwan[1,]
Mukul Mathur[2]
Manaswi Tripathi Mishra[3]
Rajesh Saini[4]
Akash Manohar Thokal[5]
Abhishek Gupta[6]

BDS[1]
Rajasthan Dental College & Hospital

MDS[2]
Dept of Oral & Maxillofacial Pathology
Senior Resident,
SMS Medical College & Hospital, Jaipur

MDS[3]
Dept of Oral & Maxillofacial Surgery
Senior Resident,
SMS Medical College & Hospital, Jaipur

MDS[4]
Dept of Prosthodontics
Senior Resident
SMS Medical College & Hospital, Jaipur

MDS[5]
Dept of Oral & Maxillofacial
Pathology & Microbiology
Private Practitioner

BDS, Private Practitioner[6]

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Abstract:

Since 25 years, dental implants have evolved into an ascertainable technology for replacement of teeth. Since the dental implants have increased, incidences of peri-implant diseases are also growing. 2 forms related to peri-implant diseases; peri-implant mucositis and peri-implantitis. Several causative elements are accountable for the occurrence of peri-implantitis with bacterial biofilm performing the significant role. Proper assessment & proper treatment of peri-implant mucositis & peri-implantitis is important to avoid the implant loss. For the treatment of peri-implant diseases different conservative & surgical technique are accessible.

Introduction:

Since 25 years, dental implants have evolved into an ascertainable technology for the replacement of teeth. Inspite of good results, almost all complication occurs at the starting of healing period and 1st year of loading these problems appears at alimentation and retaining period of implants.[1] The tissues around dental implants are vulnerable to infection that may cause implant loss.[2] Due to insufficiency of connective fiber to insert & dropped vascular force around implant, there is greater vulnerability to plaque induced inflammation.[3] Biological difficulties affecting dental implants are mainly refer to inflammatory conditions associated with a bacterial challenge.[4] 2 clinical forms may be distinguished: peri-implant mucositis and peri-implantitis. While the existence of an inflammatory lesion is a common feature of both conditions, while the second form has a feature of latter of bone loss.[5] It's antedate that mucositis is followed by peri-implantitis.[6]

Peri-Implant Diseases

The tissue around an implant usually develops inflammatory lesions which are inclusively honored as peri-implant diseases.[7] However the philanthropist can lose an implant, if these conditions are left undressed. Exploration indicates that 1 in 4 people who have dental implants are to be expected to have a peri-implant disease at certain point in their life (Wang et al., 2017).[8]

Peri-implant disease includes two forms:

a. **Peri-implant mucositis:** is a amendable inflammatory change of the peri-implant soft tissues with absence of bone loss.[9]
b. **Peri-implantitis:** is an inflammatory response associated with bone loss of supporting around an implant in function.[9]

Peri Implantitis

It is a contagious state of the tissues around implants with loss of bone and clinical feature of. It was first reported by Levignac in 1965.[10] The word peri-implantitis was given by Mombelli in 1987.[11]

The peri-mucosal seal which shapes all over the coronal area of an implant is around 3mm in corono-apical course & compresses of 2 ambit epithelium & connective tissue. Peri-implant mucosa varies from gingiva in its reduced vascularisation, reduced collagen quantity & absence of CT fibre inclusion; however the incendiary reaction to plaque is alike. The soft tissue seal that's analogous to the epithelial attachment of the tooth shield implant-bone interface by refraining from bacterial irritants, opposing mechanical pressure of restoration, mastication pressure & oral hygiene sustenance.[12]

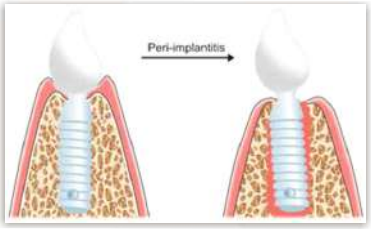

Fig. 1: Schematic illustration of healthy periodontium and peri-implantitis lesion

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Peri-implant mucosa	Physiological periodontium
Desmosomes and hemidesmosomes of epithelium and junctional epithelium (biological width) are linked with the contact surface	
Direct bone-to-implant contact	Anchoring system of root cementum, alveolar bone and desmodontic fibers
Subepithelially more collagen fibers and less fibroblasts/vessels	Subepithelially more fibroblasts and vessels
Parallel collagen fibers in relation to implant surface	Dentogingival, dentoperiostal, circular and transseptal fiber orientation

Table 1 Comparsion between Peri implant mucosa and physiological periodontium [13]

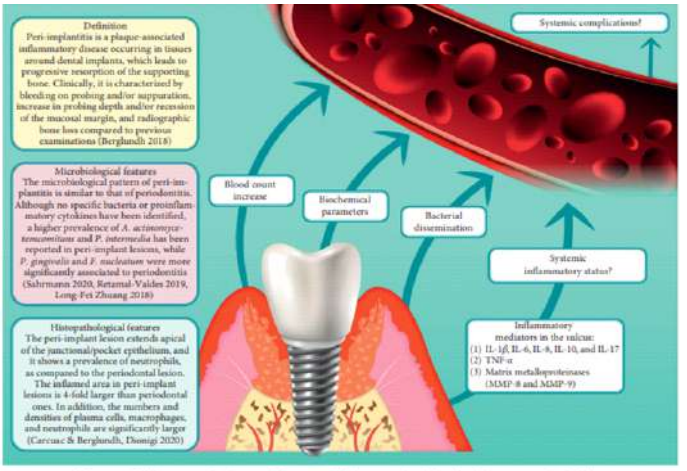

Figure 1: Different mechanisms of the potential impact of peri-implantitis on systemic health.

Prevalence

According to some researches the occurrence of mucositis & peri-implantitis ranges from 5% - 63.4%. It is substantially grounded on varying study designs and population sizes.[14]

Zitzmann et al. concluded chances of occurrence of peri-implantitis is almost 6 times higher in people with a record of periodontitis as compared with patients with no record of periodontitis.[15]

After 10 years, 10% - 50% implants manifest the feature of peri-implantitis.[16] According to Consensus Report of 6th European Workshop in Periodontology, Lindhe & Meyle showed that chances of mucositis is till 80% &of peri-implantitis amid 28% -56%.[17]

Mombelli et al., concluded that implanted patients had 20% chances of peri-implantitis & 10% in all inserted implants.[18]

Etiology

The leading cause of peri-implant diseases is microbial colonization. The plaque development pattern identified on oral implants is similar to those observed on teeth.[19] The subgingival microflora associated with implant failures due to infection are the same as those associated with adult periodontitis. Subgingival staphylococci (S. aureus and S. epidermidis) have been isolated from about 50% of gingivitis and periodontitis patients and from 55% of a small sample of ailing or failing implants.[20] A notable finding was that staphylococci were seen in 15% of cases with periimplantitis but only in 1.2% of periodontitis and 0.06% in gingivitis. As the difference was a statistically significant, the authors concluded that staphylococci play a role in some implant failures. Recently, microbiological DNA-probe scanning showed that people with peri-implantitis have high levels of periodontal microorganisim like Actinobacillus actinomycetemcomitans, Porphyromonas gingivalis, Prevotella intermedia, Bacteroides forsythus and Treponema denticola.[21]

Peri-Implantitis Risk Factors

1. Patient-Related Risk Factors

a) Periodontal Disease

Peri-implantitis is constantly presents with pronounced microbial variety and deeper peri-implant pockets exhibit notable microbial differences & advance situation of dysbiosis.[22] Periodontal disease is linked with periimplantitis.[23]People having periodontitis have double threat of having peri-implantitis compared with healthy individualities.[24] Luckily, fruitful treatment of periodontal disease before the insertion of implant appears to have lesser chances of peri-implantitis [25] and is thus treated as important step in overall treatment plan.

b) Inadequate Maintenance Therapy

Supportive therapy significantly lower the risk of peri-implant biological complications, and a minimum recall interval of 5–6 months is recommended.[26] Factors used for risk assessment includes percentage of BOP, prevalence of active residual pockets, oral hygiene level, smoking habits and the presence of systemic or genetic conditions.[27] Individuals with high-risk profiles require 3 to 4 annual visits and their attendance is detrimental for prevention and early detection of peri-implantitis.[28]

c) Cigarette & smokeless Tobacco

Smoking affects innate and adaptive immune reaction, decreases the host responses to microbial threat.[29] as well as affects wound healing.[30] Smoking also elevates the oxidative stress and inflammatory burden with pronounced changes in microbial flora. It mainly acts on affects implant's accumulation with periodontal pathogens like Porphyromonas gingivalis and Fusobacterium nucleatum.[31] Apart from having harmful effect on smokers,bare exposure of environmental smoke to a person increases threat of periodontal disease by 28%[32] The association of water pipe smoking with periodontal disease have been proved by many studies.[33] Likewise water pipe smokers have higher chances of having periodontitis in comparision with cigarette smokers, but determinal effects are linked with the period and the amount of daily use.[34]

d) Systemic Conditions

- **Diabetes mellitus –** Uncontrolled diabetes have a important role in the advancement of periodontitis.[35] This linkup is illustrated by vascular & cellular reactions, directing increased tissue loss & reduced healing reaction.[36] Alike responses is generated in periimplant tissues; developing increased chances of periimplantitis in people enduring from hyperglycaemia.[37] People with uncontrolled diabetes have around fortysix percent chances of having peri-implantitis, along with deeper periimplant pockets & excessive marginal bone loss, in contrast with people with having controlled diabetes.[38]
- **Obesity-** an aberrant or inordinate body fat inflation with depleting effects on general health.[39] It's related with pronounced physiological shift, along with diabetes mellitus & coronary heart disease.[40] It is connected with distinct & sustained hyper-inflammatory state, leading to altered immune response & elevated level of proinflammatory cytokines, that negatively alter the periodontal tissues & alveolar bone levels.[41] Researches have concluded that obesity leads to peri-implantitis. In comparsion with individualities having average body weight, obese people have increased index of BOP, deeper peri-implant probing depths & excessive marginal bone loss.[42] The gravity of peri-implant inflammation is notably related with stage of obesity.[43]

• **Association between cardiovascular diseases and periimplantitis.**

Patients suffering from heart disease have increased risk of having peri implant diseases and additional bone loss.[44]

- **Rheumatoid arthritis**

Krennmair G et al concluded that with consequent connective tissue infection is linked with increased index of BOP and periimplant bone loss.[45] Korfage A et al showed that people with Sjögren's syndrome didn't had an increased risk of peri-implantitis still increased chances of mucositis in the case group may show increased vulnerability to peri-implantitis.[46]

- **Osteoporosis**

A study concluded that there is an increased marginal bone loss & implant thread exposure with bisphophonates absorption.[47] A current study concluded that a low-dose BP didn't exert influence on the bone around implant.[48]

e) Genetic Factors

In spite of the common theory of some genetic predisposition to peri-implantitis, a clear linkup with some threat variable is yet to be resolved.[49] Interleukin-1 (IL-1) polymorphism is involved in the coding of 2 chief pro-inflammatory cytokines, IL-1α & IL-1β, along with anti-inflammatory IL-1 receptor antagonist. Growing quantity of both IL-1α & IL-1β is related with peri-implantitis, & there amount are associated with the gravity of the infection.[50]

f) Occlusion

Excess load at, peri-implantitis concerned areas have excessive marginal bone loss in contrast with mucositis.[51] The patterns of bone resorption diversed notably all over overloaded implants & with ligature caused peri-implantitis.[52] The consequence of overburdening on periimplant bone levels isidentified by sub-optimal implant positioning, defective prosthesis, insufficient bone level or its bad quality. Para-functional habits leads to increased non-axial occlusal forces which causes marginal bone loss.[53]

Attrition & wear of natural dentition or prosthetic reconstructions probably acclimated for excessive occlusal load& parafunctional habits.[54]

2. Implant Related Factors

a) Implant Surface

Implant's roughness & surface energy has an effect biofilm development, but everlasting-impact on the inflammatory response & bone stability still determinal.[55] some researchers showed that rough implants are vulnerable to peri-implantitis[56] while others didn't showed any notable variance between rough & moderately rough surfaces.[57]

b) Ill fitted Prosthesis

The outline of prosthesis largely mainly adds to the implant's durability. Ill fitted prosthesis possibly hinders plaque control, which rises threat of progressing peri-implant infection.[58] An ill marginal fit have a deleterious effect which causes development of peri-implantitis.[59] the chances of having periimplantitis in cemented implant restorationis 3.6 times in contrast to screw reatained.[60] It occurs because excess cement is left in the sub-mucosal region, mainly when resin luting agents is used.[61] So, deep sub-mucosal margins must be evaded for proper transparency & way access for cement scrapping.[62]

c) Peri-Implant Soft Tissue Conditions

The soft tissue situation over an implant may lead to peri-implant disease. People with thin periodontal phenotypes are susceptible to peri-implant mucosal recessions. The vulnerability of an implant's rough surface to the oral cavity impedes plaque control & increases bacterial adhesion, causing gain in the vulnerability to peri-implantitis.[63]

d) Iatrogenic Factors

Implant malpositioning appears as an important peril for peri-implantitis. When an implant is positioned near about the natural teeth or to an another implant crestal bone resorption take place.[64]

e) Inadequate Plaque Control

Patient taking steps to control the plaque impact implant's outcome. A high plaque score is companied with octuple rise in the vulnerability to peri-implantitis. The cumulation of dental plaque on implant & abutment surfaces causes peri-implant inflammation, called mucositis.[65]

Etiopathogenesis of Peri-implantitis

The marginal inflammatory tissue response in implants is analogous to that seen in gingivitis and periodontitis of teeth. Once the plaque accumulation is started; neutrophils are signed to the periodontal pocket or the gingival crevice due to the chemotactic peptides, secreted by the bacteria. Likewise bacteria harm the epithelial cells, they beget epithelial cells to secrete cytokines that facilitate attraction of leukocytes mainly neutrophils to the crevice. The neutrophils inside the crevice phagocytose & digest bacteria and thus, take off the bacteria from the pocket. It degranulates if the neutrophil becomes overburden with bacteria. It results in tissue injury from toxic enzymes which are secreted from neutrophils. Finally, if there is an overburden of microbial plaque, the neutrophils and the barrier of epithelial cells won't be sufficient to control the infection. In such situation, the gingival tissue gets inflamed. However if inflammation increases from the marginal gingiva into the supporting periodontal tissues, it causes bone destruction & loss of attachment, which is known as periodontitis. Bacterial plaque products activate the differentiation of bone progenitor cells into osteoclasts & trigger gingival cells to secrete mediators that give same outcome. Certain host factors secreted by inflammatory cells are efficient in activating bone resorption in vitro & causes periodontal disease. It includes host produced prostaglandins & certain cytokines (IL-1, TNF-α etc).[66]

Classification of Peri- Implantitis

The classification systems of peri-implantitis are-:

1. Classification based on distinct clinical stages [67]

Early	Probing depth greater 4 mm (bleeding and/or suppuration on probing) bone loss less than 25 % of the implant length
Moderate	Probing depth greater or equal to 6 mm (bleeding and/or suppuration on probing) Bone loss 25% - 50% of the implant length
Advanced	Probing depth greater or equal to 8 mm (bleeding and/or suppuration on probing) Bone loss less than 50% of the implant length

2. Classification based on bone defects adjacent to dental implants highlighting the defect anatomy in the progression of the regenerative process[68]

a. Closed defects	maintenance of intact surrounding bone walls
b. Open defects	Absence of 1 or more bone walls.

3. Classification based on the clinical status.[69]

Staging	Definition
Stage I	Bleeding on probing &/Suppuration & bone loss less than 3 mm beyond biological bone remodelling
Stage II	Bleeding on probing &/Suppuration & bone loss less than 3 mm & greater than 5 mm beyond biological bone remodelling
Stage III	Bleeding on probing &/Suppuration & bone loss greater than 5 mm beyond biological bone remodelling
Stage IV	Bleeding on probing &/Suppuration & bone loss greater than or equal to 50% of the implant length beyond biological bone remodelling

4. Classification based on bleeding on probing, probing depth, percentage of bone loss and mobility[70]

STAGE	Bleeding on Probing	Probing Depth	Bone loss (%) of implant length	Mobility	Proposed Treatment & Prognosis
STAGE 1	–	2–3 mm	10–25%	No mobility	No treatment
STAGE 2	+	4–6 mm	25–50% Vertical Horizontal combination	Grade 1	vertical defect <2– 4 mm- GBR, osteoplasty Horizontal Defect < half of implant height – APF, GBR, osteoplasty Combination Defect: Bone augmentation and GBR. Prognosis is fair.
STAGE 3 Horizontal	+	6–8 mm	>50% Vertical Horizontal combination	Grade 2	vertical defect 2– 4 mm-GBR, ABWG Defect > half of implant height – GBR and Augmentation. Combination Defect: Implant removal. Questionable Prognosis
STAGE 4	+	>8 mm	> 50%	Grade 3	Implant removal Poor prognosis

APF- Apically positioned flap, GBR- Guided bone regeneration, ABWG- Autogenous bone wedge grafting.

5. Classification of retrograde peri-implantitis[71]

Class I (Mild)	*Extends greater than 25% of the implant length from implant apex.*
Class II (Moderate)	Extends 25 to 50% of the implant length from implant apex.
Class III (Advanced)	Less than 50% of the implant length from implant apex.

6. Classification based on defect morphology

a. Based on amount of bone loss with shaped of defect associated[72]

1. Class 1: Slight horizontal bone loss with minimal peri-implant defects
2. Class 2: Moderate horizontal bone loss with isolated vertical defects
3. Class 3: Moderate to advanced horizontal bone loss with broad, circular bony defects.
4. Class 4: Advanced horizontal bone loss with broad, circumferential vertical defects, as well as loss of the oral and/or vestibular bony wall

b. Based on the configuration of the bony defect as[73]

1. Class I defect – Intraosseous
2. Class II defect – Supra-alveolar in the crestal implant insertion area.

c. Based on type of bone resorption pattern.[74]

1. Class I – Horizontal
2. Class II – Hey-shaped
3. Class III a – Funnel shaped
4. Class III b – Gap-like
5. Class IV – Horizontal-circular form

Features of Peri-Implantitis

1. Increased reddishness & swelling.
2. Bleeding on probing
3. Suppuration
4. Peri-implant pocket (>4mm).
5. Pain on mastication
6. Supra occlusion at implant site
7. Mobility – final grade of peri-implantitis (Mombelli & Lang, 1998)[75]

Radiographic Characteristic:

Generally takes the form of saucer throughout the implant & is well defined (vertical bone destruction with periimplant pocket).[75]

Diagnostic Parameters:

1. Radiographic Evaluation

The sustention of marginal bone height is believed pivotal for implant sustenance & frequently used as essential basis for implant's success. Vertical bone loss lowers than 0.2 mm yearly subsequently after the implant's 1st year of service is suggested as the significant basis for gain. For the precise evaluation of bone level alert rations, long-term sequence of standardized radiographs are needed. Suggested of radiograph 1 year after implant placement, but another radiograph is required to judge the range of marginal bone loss if clinical variable shows clinical feature of peri-implant disease.[75]

2. Peri-implant probing

Stable fixed place is used on an implant abutment or prosthesis for a dependable dimension of attachment levels. Peri-implant probing must be averted in the first 3 months after abutment connection to evade the interference in healing & formation of soft tissue seal. The peri-implant probing attachment position matches nearly with radiographically assessable peri-implant bone level differences. Should be included in every maintenance recall session.[75]

3. Bleeding on Probing

BOP shows inflammation of soft tissue either over natural teeth or implants. BOP is a bad determinant of advancement of periodontal disease though showing no existence at consecutive maintenance appointment perhaps is good negative seer of attachment loss. A favourable relation is assumed between BOP & histologic signs of inflammation at peri-implant place.[75]

4. Suppuration

Large amount of leukocyte are present at implant site that which shows increasing gingival inflammation. Suppuration is closely linked to disease activity & indicates shows for the requirement of anti infective therapy.[75]

5. Mobility

It is the sign of absence of osseointegration. Bone destruction can continue besides any notable signs of implant mobility till osseointegration is fully lost. Indeed if disease situation in the peri-implant tissues have grown implants can even show immobility because of enduring direct bone to implant contact. This variable helps to identify the last stage of osseointegration and may aid in choosing implant removal.[75]

6. Implant Stability

Two non-invasive approaches developed are

a. Perio-Test

A non-invasive, electronic device which offers an assessment of the response of periodontium to determine the smack of load exerted on the tooth crown. A score more than 5 shows severe mobility & explanation (Mombelli & Lang, 1998).[75]

b. Resonance Frequency Analysis (RFA)

It uses a sensor which is a fixed to the implant or abutment. The RFA value is a province of the firmness of implant in the adjacent tissues.[76]

7. Plaque Assessment

Swelling & reddishness of marginal tissues is described from peri-implant infections. These peri-implant variables are grounded on periodontal indices like Sulcus Bleeding Index & Gingival bleeding Index. The bleeding propensity of the marginal peri-implant tissues may be evaluated by Modified Sulcus Bleeding Index. Quantity of plaque on implants could be evaluated by Modified plaque index.[75]

8. Microbiology Test

Checking the subgingival microflora is suggested to decide the increased risk of periodontal disease or peri-implantitis. It is good to base systemic antimicrobial therapy grounded on microbiological data (Mombelli, 2002).[76]

9. Peri-Implant Crevicular Fluid

MMP-7 & MMP-8 is considerably higher infected peri-implant sulcular fluid as collate with study individual. The amount of laminin-5 & Gelatinase B are increased at infected sites.[76]

Management Modalities of Peri-Implantitis

The oral micro flora appears to be the describing element for the success or the failure of a dental implant. When implant surface is assailable to the oral cavity, get covers by a protein layer – the salivary pellicle – & are inhabited by oral microorganisms, forming a microbial biofilm. Surface debridement is essential for treating both periodontitis and peri-implantitis. Mechanical debridement of such surfaces has a less effect & clearly doesn't completely remove of all adhering microorganisms. Thus, additional peri-implant therapies, like antibiotics, antiseptics, & ultrasonic & laser treatments, are suggested to enhance the non-surgical treatment options of peri-implant mucositis & peri-implantitis. Regenerative procedures using a bone graft substitute in combination with a membrane is suggested in treating bone defects in advanced cases of peri-implantitis.

1. Local Debridement

The implant are suppose to be cleaned by instruments smoother compared to titanium, like polishing with a rubber cup & paste, floss, interdental brushes, or using plastic scaling instruments. These doesn't roughen the implant surface unalike metal & ultrasonic scalers.[77] Though implant surface damage can nearly be averted by using either ultrasonic scalers with a nonmetallic tip or resin/carbon fiber curettes, the presence of implant threads & or implant surface roughness may jeopardise the access for cleaning.[78]

The research done by Karring et al. showed that sub-mucosal debridement alone, fulfilled by either an ultrasonic device or carbon fiber curettes, isn't sufficient for the disinfection of the surfaces of implants with peri-implant pockets greater than 5 mm & exposed implant threads.[79]

1. Implant surface decontamination

Four implant surface decontamination ways were compared in a monkey model:

(1) Air-powder abrasive technique followed by citric acid application

(2) Air-powder abrasive technique

(3) Gauze soaked in saline followed by citric acid application

(4) Gauze soaked alternately in 0.1% chlorhexidine and saline.[80]

Findings from an in vitro study associating photosensitization by toludine blue solution and soft laser irradiation have pointed that elimination of bacteria from distinct titanium surfaces without modification of the implant surface was possible.[81]

Photodynamic therapy is a non-invasive approach that could be used to reduce microorganisms in peri-implantitis. Decontamination of affected implants with titanium plasma-sprayed or sandblasted/acid-etched surfaces may most fluently and effectively be achieved by applying gauze soaked alternatively in chlorhexidine and saline.[82]

According to Schwarz et al., the Er:YAG laser and the combination of mechanical debridement/chlorhexidine are similarly efficacious at 6 months after therapy in significantly improving peri-implant probing pocket depth and clinical attachment level, but the use of the Er:YAG laser provides a significantly advance reduction of bleeding on probing compared with the adjunctive application of chlorhexidine.[83]

2. Anti-infective therapy

Patients suffering from localized peri-implant problems in the absence of other infections may be campaigners for treatment by local drug-delivery devices. Local application of antibiotics by the insertion of tetracycline fibers for 10 days can give a sustained high dose of the antimicrobial agent precisely into the affected site for several days. The use of minoccline microspheres as an adjunct to mechanical therapy is salutaryl in the treatment of peri-implant lesions, but the treatment may have to be repeated.[84] The study by Renvert et al.showed that the adjunctive benefits deduced from the addition of an antibiotic minocycline to mechanical debridement tend to be greater, although to a limited extent, than those attained by the combined use of an antiseptic (chlorhexidine) and mechanical debridement. The advancement in peri-implant probing depths attained by the adjunctive use of minocycline can be maintained during a short-term period of 12 months.[85]

If the problem is generalized, specific microbiological information is collected and antibiotics are administered systemically. Lang et al. suggest the following antibiotic regimes: systemic ornidazole 500 mg bd for 10 days or metronidazole 250 mg td for 10 days or a once daily combination of metronidazole 500 mg and amoxicillin 375 mg for 10 days.[86]

3. Surgical technique

Surgical resection is usually confined to implants placed in non-aesthetic sites. Surgical flap helps in complete debridement and decontamination of the affected implant. Surgical therapy was carried out, using:

(1) Autogenous bone grafts covered by membranes,
(2) Autogenous bone grafts alone
(3) Membranes alone
(4) A control access flap procedure showed that defects treated with membrane-covered autogenous bone showed significantly larger amounts of bone regeneration and reosseointegration than those treated with the other three procedures. However, membrane exposure is a frequent complication after such procedures. Exposure of porous e-PTFE membranes may result in bacterial penetration and lead to infection.[87]

Conclusion

Use of dental implants for replacement of missing teeth has become the norm in oral rehabilitation in recent days. Though implants have shown effective and predictable results, increase in use of dental implants has also been associated with occurrence of implant failures of which the most common cause is peri-implantitis. Peri-implantitis is progressive destructive chronic diseases of bacterial or mechanical origin that affects hard and soft tissues surrounding the implant. The prevalence of peri-implantitis at implant level ranged between 6.5% -47% and prevalence at patient level ranged between 18.8% - 47%.

Looking at etiology, dental plaque and associated micro-organisms has been universally identified as the primary etiologic agents. The second factor identified as etiology is the mechanical factors. Apart from these, a number of risk factors have been associated with peri-implant diseases like local factors (parafunctional habit, local anatomic factors, etc.), systemic factors (age, genetics, medical conditions, etc.), behavioral factors (oral hygiene maintenance, patient compliance). On analyzing the evidence for microbiologic profile of peri-implantitis, following micro-organisms were more prevalent Porphyromonas gingivalis (PG), Prevotella intermedia, Treponema denticola (TD), Looking into treatment of peri-implantitis both non-surgical and surgical interventions have been analyzed. Non-surgical therapy included alteration of implant surface, soft tissue debridement and adjunctive use of anti-microbial, lasers and host modulatory agents. Non-surgical therapy is effective only in eliminating the local etiologic factors and might not the effective in osseous defects. Surgical interventions include reflection of flap, debridement and use of various bone grafts material and membranes.With increase in awareness and demand for replacement of missing teeth with dental implants, peri-implant diseases are also increased.

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A Review

Metamorphosing of Speckled Leukoplakia into Carcinoma - A Review

Dr. Gurleen Kaur Sandhu,
B.D.S
gurleen.sandhu01@gmail.com

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Abstract

Potentially malignant conditions precede malignancies. Oral squamous cell carcinoma has several antecedents, including leukoplakia. One of the leukoplakia varieties that usually develop into cancer is speckled leukoplakia. A significant diagnostic and therapeutic difficulty is posed by speckled leukoplakia. We have described a case of speckled leukoplakia on the right side of the buccal mucosa that developed into cancer in situ along with a review of the literature in light of recent findings. We also made an effort to discuss the clinical significance and treatment options available for the condition.

Key Words: Malignancies, potentially malignant disorders, speckled leukoplakia, Carcinoma

Introduction

The general public is becoming more aware of lesions in the oral cavity that may be cancerous. Leukoplakia is a oral cavity lesion that has been discovered. The term "leukoplakia" comes from Greek words "plakia," which means plaques or patches and "leuko" which means white. Leukoplakia is therefore described as a white plaque that cannot be removed by scraping. However, even after removing all risk variables with no inclination toward malignancy, still its origin remains unclear [1]. Leukoplakia is a lesion that affects around 3% of people globally, and 5- 25% of cases are pre-malignant lesions. All leukoplakia lesions might be taken into consideration as possible malignant lesions if confirmed by histological analysis.[2] The term Speckled Leukoplakia (SL), which was used by the World Health Organization (WHO) is now used to refer to the existence of both white and red areas on the oral mucosa.[3] Speckled leukoplakia instances in India are quite rare. This case report describes a case of speckled leukoplakia that affected the right side of the buccal mucosa and reached the alveolar area. With a high probability of malignant transformation and a precursor lesion of squamous cell carcinoma, SL is an uncommon and extremely aggressive clinicopathological condition.

Case Report

A 58-year-old man who had a white spot on his buccal mucosa came to the clinic. The white area, whose steady development caused discomfort and a burning sensation, was initially detected one year ago. He had been a smoker since he was about 29 years old, but he hasn't smoked in over 5 years. Additionally, he had been chewing raw tobacco two to three times a day for the past ten years. The patient also occasionally drank beer in addition to these. The right buccal mucosa underwent intraoral examination which revealed 2 × 2 cm red and white patches that were firm, non-tender, and non-scratchable. [Fig.1] The surface seemed uneven and somewhat raised, clinically resembling speckled leukoplakia. Red splotchy spots were intermingled with the lesion. To choose the location for the biopsy, toluidine blue staining was done while the patient was in the chair. The chosen region was then biopsied (incision). [Fig.2] Squamous epithelium covering connective tissue stroma was seen during histopathologic investigation using H and E-stained sections. The epithelium displayed dysplastic characteristics such as wide rete ridges, acanthosis, hyperchromatism, basilar hyperplasia, cellular and nuclear pleomorphism, aberrant mitosis, individual cell keratinization and production of intraepithelial keratin pearls. Top to bottom, dysplastic epithelial alterations were seen. The stroma of connective tissue was highly cellular and contained numerous chronically inflamed cells as well as dilated and thriving capillaries. [Fig:3,4,5] The transformation of speckled leukoplakia into cancer in situ was determined to be diagnosed on the basis of overall clinical and histological findings.

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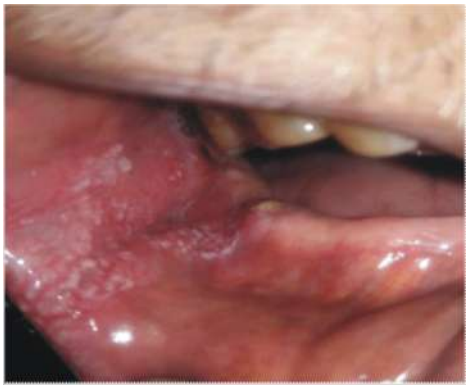

Figure 1: Showing speckled leukoplakia in right side of buccal mucosa.

Figure 2: Grossing image showing tissue of incisional biopsy.

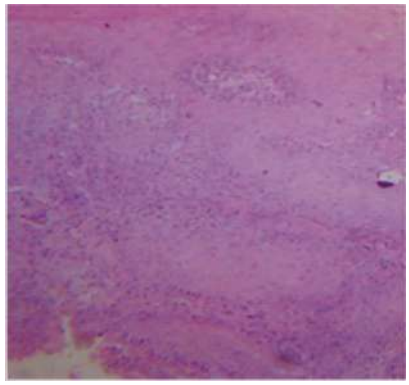

Figure 3

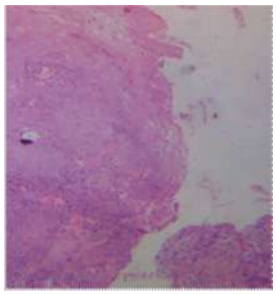

Figure 4

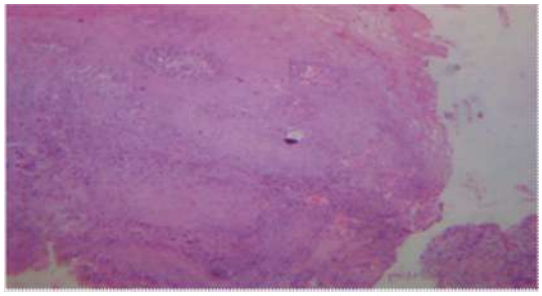

Figure 5: Histopathology showing Speckled leukoplakia transforming into Carcinoma in situ [H & E X10]

Discussion

According to the World Health Organization, leukoplakia is a white patch or plaque that cannot be diagnosed as any other disease, either clinically or pathologically and is only caused by smoking. No other physical or chemical agents are known to cause leukoplakia.[5] However, the research makes a compelling case for the involvement of viruses, alcohol, and underlying health issues. The occurrence of both white and red patches on the oral mucosa is known as speckled leukoplakia (SL) according to the World Health Organization (WHO).[6] Homogeneous and non-homogeneous leukoplakia are the two primary clinical kinds of leukoplakia. Non-homogenous leukoplakia is the term used to describe speckled leukoplakia.

The etiology of cancer is influenced by several variables, including the consumption of alcohol and cigarettes, diets low in antioxidants (such as vitamins C, E, and beta-carotene), occupational exposure to carcinogens, viral infections, genetic and hereditary factors, and others. The usage of tobacco products was shown to be the most potent independent risk factor. An additional list of contributory variables included hyperacidity, lipstick, ill-fitting dentures, and other tobacco products, highlighting the influence of socioeconomic status and way of life on the emergence of premalignant lesions.[7] Several names have been used to describe the presence of both white and red patches. Lesions known as erythroplakia are completely red. SL is indicated by red and white patches on the mucosa.[4]The chance of speckled leukoplakia turning malignant is greater than that of other varieties. Therefore, early detection by biopsy is necessary to prevent potentially deadly malignant transformation.[8] Approximately 80% of SL eventually develop into oral carcinoma over time, despite a range of therapies. Contrastingly, 5–10% of homogeneous leukoplakia will develop into a carcinoma.[4] SL is resistant to the majority of existing therapeutic options, including surgery [4]. Therefore, complete excision with unrestricted surgical margins and lifetime monitoring is essential. Leukoplakia has a greater malignant potential in women (6%) than in males (3.9%). Compared to ordinary leukoplakia, those linked with tobacco chewing have a greater risk of malignant transformation[7]. In the commissure area and buccal mucosa malignant transformation can occur in 1.8 percent of cases. Malignant transformation have been found in the area of the lip and tongue in 16–38% of cases. It has been shown that the yearly malignant transformation rate ranges from 0.1% to 17%.[9]

Management

When determining the type of treatment for the patient, the degree of epithelial dysplasia is crucial. Two risk groups were identified by Martorell Calatayud[10] along with the ensuing therapeutic options:

Group 1: Individuals with minimal malignancy risk, those homogeneous leukoplakias that appear clinically as leukoplakias without dysplasia, those in low-risk locations that exhibit minor dysplasia, those with a thickness of less than 200 mm, etc. In this group, a variety of therapy modalities can be used as treatment of lesions using topical or oral retinoids, such as 1.5–2 mg/kg body weight for three months of 13-Cis-Retinoic Acid 10 mg treatments utilizing non-surgical ablative methods, such as carbon dioxide laser ablation and cryotherapy. In this low-risk category, laser light therapy is seen to be the best option since it has shown superior outcomes in terms of managing the lesions.

Group 2: Those who are at a high risk of developing cancer, which includes: Leukoplakias with mild dysplasia that are present in high-risk areas and measure more than 200 mm or those linked to a nonhomogenous clinical form; Leukoplakias with moderate or severe dysplasia and Verrucous leukoplakias. The aggressive surgical approach of removing the full thickness of the mucosa at the leukoplakia site is advised for this group of patients. This is comparable to the current situation. Although there are numerous alternative treatments available, avoiding risk factors (such as smoking and drinking) and etiological factors (such as sharp fractured teeth, defective metal restorations, and metal bridges) are a preventative approach that could be used on all patients with these lesions.[8] Both in treated and untreated patients, routine check-ups of these individuals are crucial, likely every 3, 6 and eventually 12 months.

Conclusion

Speckled leukoplakia is a condition in patients that might be cancerous. Any potentially cancerous condition should be actively addressed. Early diagnosis is crucial for both treatment and prognosis of speckled leukoplakia due to the high malignant transformation rate of this condition.

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A Journal of Advanced Dentistry
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A Survey

Trends in Usage of Dental Lasers and iIts Perception Amongst Dental Surgeons of Northwest India - A Cross Sectional Survey

Bhavika Gupta[1]
Arpit Sikri[2]
Urvi Marwaha[3]
Tarun Kalra[4]
Aryan Wadehra [5]

Intern[1]
Dr. Harvansh Singh Judge Institute of Dental Sciences & Hospital, Chandigarh;

Associate Professor & Post Graduate Teacher[2]
Dept. of Prosthodontics & Crown & Bridge, Bhojia Dental College and Hospital, Baddi, Himachal Pradesh

Post Graduate Student (3rd Year)[3]
Dept. of Prosthodontics & Crown & Bridge Bhojia Dental College and Hospital, Baddi, Himachal Pradesh

Principal, Professor & Head[4]
Dept. of Prosthodontics & Crown & Bridge Bhojia Dental College and Hospital, Baddi, Himachal Pradesh

Intern[5]
Dept. of Prosthodontics & Crown & Bridge Bhojia Dental College and Hospital, Baddi, Himachal Pradesh

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Abstract

Background: Despite being around since 1960s in the field of medicine, the acceptance of Lasers is still limited in dental practices. This study is to evaluate the prevalence of Lasers, its practice for periodontal procedures in dental clinics of Delhi NCR and Chandigarh Tricity (North-West India region) and to assess the perception of dental surgeons towards training, patient acceptance, and possible trend in usage in a post COVID 19 era.

Methods: An online, validated questionnaire of 25 questions was distributed amongst 200 dental surgeons in Delhi NCR and Chandigarh Tricity region. The survey was divided into 6 sections; first section contained questions regarding demography of respondents, second section was for those who use Lasers in their practice, third section was for those who don't use dental Lasers, and the next three sections were for all the respondents, evaluating perception of dental surgeons on training needs, acceptance of patients to Lasers and the probable trend in LASER usage in a post pandemic world.

Result: A response rate of 61.5% was achieved with 123 dental surgeons responding to the survey. 42.3% dental surgeons reported to use Lasers in their practice with a majority of 74.5% using diode Lasers. Most dental surgeons reported that they used Lasers for soft tissue surgical procedures like gingivectomy, gingivoplasty, frenectomy, soft tissue crown lengthening followed by bacterial reduction therapy like periodontal pocket disinfection and Laser assisted periodontal therapy (LAPT). The major barriers preventing dental surgeons from adopting Laser dentistry include lack of guided training and high initial investment costs. 29% dental surgeons using a Laser received training during formal graduation or post-graduation training and 27% received training through continuing dental education programs (CDEs) and hands on courses. Majority dental surgeons agree that there is good patient acceptance to Lasers and that Lasers add a brand value to their clinical practice. Most dental surgeons (64%) will be willing to invest in Lasers if they are made cheaper and are unsure if Laser usage is safe or will improve in the near future of a post COVID world.

Conclusion: Diode Lasers are the most commonly used type of Lasers in dental clinics of Northwest India. Integrating theoretical and practical training in formal curriculum can play a key role in better acceptance of dental Lasers amongst dental surgeons.

Introduction

Laser stands for Light Amplification by Stimulated Emission of Radiation. In 1960, Maiman built the first working LASER gadget utilizing a synthetic pink ruby crystal as the active LASER medium.[1] Since then, Laser technology has taken the medical field by storm with the various new Laser systems being created and improved for better application in medicine and dentistry.

Lasing occurs via the spontaneous emission of a photon by an atom, stimulating the release of another photon and so on: generating a coherent (photons emitted vibrate in phase agreement in space and time), monochromatic (waves emitted have same wavelength and energy), and collimated (constant size and shape of the beam emitted) beam of light.[2,4]

This light is produced by energizing a certain substance (called gain medium, Laser systems are usually named after its ingredients) within a resonating chamber.[3]

Light energy produced can have 4 interactions within the tissue - reflection, scattering, absorption, and transmission. The wavelength of the LASER has a profound effect on the type of interaction that takes place. For biological tissues, higher absorption occurs in wavelengths with greater absorbance in water. Absorbing of the Laser increases the temperature, producing photochemical effects.[4]

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When the temperature touches 100 degrees celsius, water vaporizes within the tissues and is called ablation. At temperatures above 60 degrees celsius and below 100 degrees Celsius, denaturation of proteins occurs without vaporization of the tissue beneath. At temperatures above 200 degrees celsius, carbonization occurs wherein the tissue is burned after becoming dehydrated.[5]

Dental Lasers have many applications in various specialities of dentistry. One of the specialties where they are used commonly is Periodontics, for both surgical as well as non-surgical treatments. Various types of dental Lasers and their common applications in periodontics have been highlighted in table 1. [6]

Materials and Methods

An electronic questionnaire was prepared using Google Form. The questionnaire contained 6 sections. Section 1 contained questions on personal information, demographic information, professional information, and if the dental surgeon used a Laser or not. Section 2 was limited to those dental surgeons who used a Laser and contained questions related to their practice and usage of Lasers. Section 3 was limited to those dental surgeons who didn't use a Laser and contained questions based on their perception of Lasers. Section 4, 5, and 6 were for all respondents and contained questions that would help estimate the dental surgeon's perception on training needs for Lasers, general patient acceptance to Lasers, and the possible trend in Laser usage in a post COVID 19world.

The questionnaire was first sent to 5 post graduate students to record their answers and validate the survey. After validation, the questionnaire was circulated amongst dental surgeons through Whatsapp, i.e.a messaging platform. The responses were recorded in an automatically generated Google Sheet document. From all the responses, the duplicate responses were removed. Ultimately, from among 200 dental surgeons to whom the form was sent personally, 123 dental surgeons filled the form: providing us with a 61.5% response rate. The sample size hence was of 123 dental surgeons practicing in the regions of Delhi NCR or Chandigarh Tri City Area (two major cities in Northwest India).

A descriptive analysis was performed on the acquired data using Microsoft Excel to study basic trends of distribution, prevalence, and common perception of dental Lasers amongst dental surgeons of Northwest India.

Results

The survey was circulated amongst 200 dental surgeons of Chandigarh and Delhi NCR, out of which 123 responded: providing a response rate of 61.5%. The result and analysis from the survey has been condensed to 6 distinct sub sections; each of which has been elaborated below.

Demographic profile of sample size:

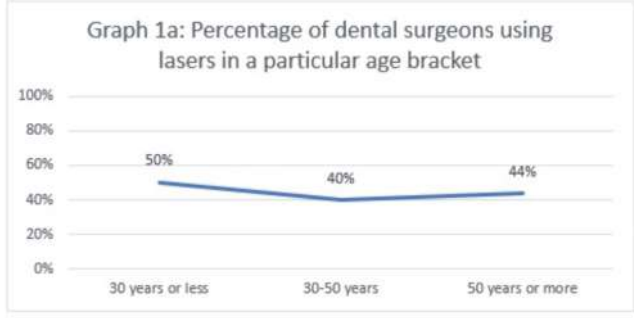
As summarized in Table 2, survey respondents were nearly equally distributed amongst the two cities involved in the study. Majority respondents were male and fell in the 30-50 years age bracket.

Respondents were also asked about the number of years they had been practicing dentistry, i.e. their dental tenure. Most had a tenure of 10-20 years, followed by a tenure of 20-30 years; indicating a sample size of seasoned dental surgeons.

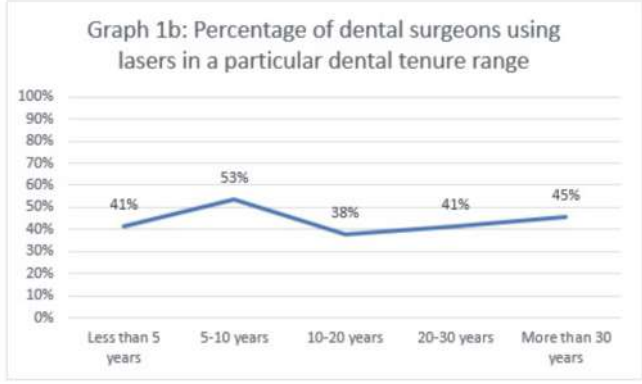
Maximum respondents owned a private practice of their own and worked in a clinic with a smaller to medium OPD size of less than 300 patients per month. Half of the sample size included general dental surgeons, followed by endodontists, periodontists, and orthodontists.

As depicted in **Graph 1a,** Laser usage is almost evenly distributed amongst all the age groups but is slightly higher in the younger age bracket. While Laser usage is relatively evenly distributed amongst all dental tenures, **Graph 1b** indicates that Laser usage is high amongst early tenure dental surgeons, especially amongst dental surgeons with 5-10 years of experience. **Graph 1c** indicates that while the absolute count of dental surgeons using Lasers is high amongst private practice owners, relatively the proportion of dental surgeons in a government college/hospital setup are more likely to use Lasers. Similarly, in **Graph 1d**, as the practice size increases, the proportion of dental surgeons more likely to use Lasers also increases while the absolute count may be much less. Dental surgeons with a post graduate qualification are more likely to use Lasers than dental surgeons with an undergraduate qualification according to **Graph 1e**.

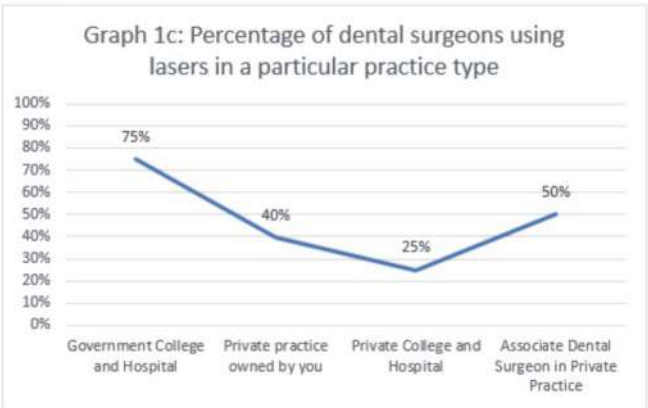
Graph 1a: Percentage of dental surgeons using lasers in a particular age bracket



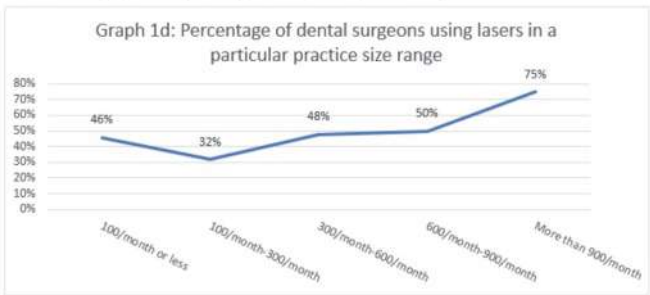
Graph 1b: Percentage of dental surgeons using lasers in a particular dental tenure range



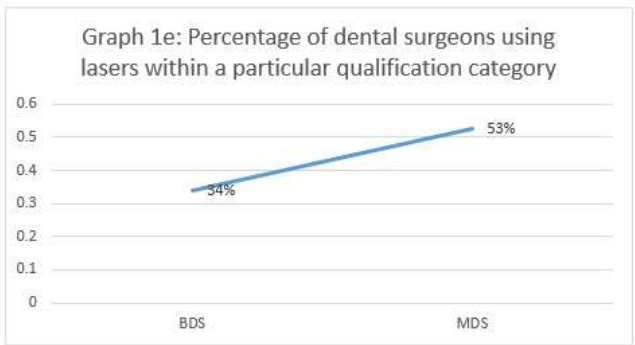
Graph 1c: Percentage of dental surgeons using lasers in a particular practice type



Graph 1d: Percentage of dental surgeons using lasers in a particular practice size range



Graph 1e: Percentage of dental surgeons using lasers within a particular qualification category



Trends amongst Laser users

As shown in Table 3, diode is the most used Laser amongst the respondents by a huge proportion. It is followed by other soft tissue Lasers like CO_2 and Argon Lasers. Only 5.1% of the respondents who used Lasers used hard tissue Lasers. Within periodontics, respondents liked to use Laser mostly for soft tissue periodontal surgeries. 15.5% dental surgeons used it for soft tissue surgical procedures like gingivectomy, gingivoplasty, frenectomy, and 14.4% used it for soft tissue crown lengthening. After soft tissue surgeries, it is commonly used for periodontal therapy procedures like periodontal pocket disinfection (13.0%), Laser assisted periodontal therapy (10.0%), treatment of peri-implantitis (8.9%), etc. Most respondents (53.8%) who used dental Lasers used them as frequently as once a week. Only 9.6% used it daily. Out of the dental surgeons who used dental Lasers, most (95.5%) kept themselves updated about Lasers and its technology. Most dental surgeons reported confidence in using a dental Laser, 38.5% said that they sometimes feel anxiety while operating a Laser.

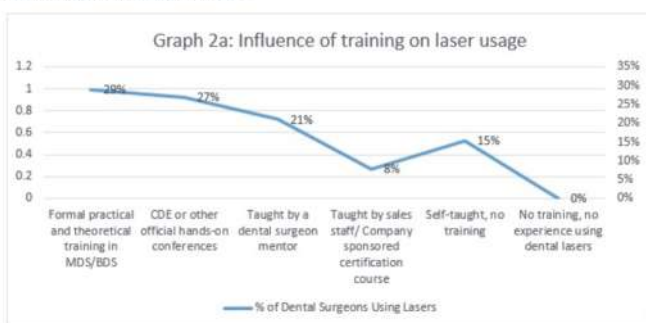
Trends amongst non-Laser users

According to table 4, 21.6% of the dental surgeons who weren't using dental Lasers in their daily practice were planning to invest in a Laser soon. As stated in the table, most (38.1%) were planning to invest in a diode Laser further emphasizing its high acceptance amongst dental surgeons. 19% were planning to invest in Er, Cr: YSGG. Amongst dental surgeons who were not using Lasers, majority did not think any measure can get them to start using dental Lasers while the response from the rest highlighted the two main barriers dental Lasers face, i.e. lack of training and high purchase cost.

Perception on training and knowledge of Lasers

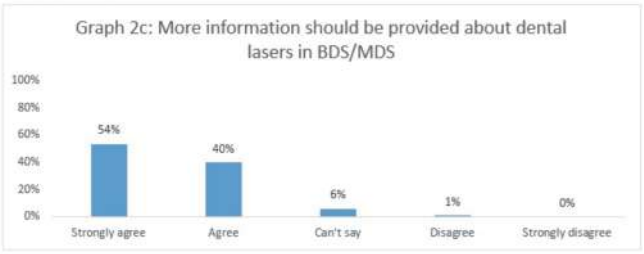
According to **Graph 2a**, most dental surgeons who used Lasers received training on Lasers through their graduation or post-graduation curriculum. Without any training or experience, no dental surgeon had used Lasers. Majority dental surgeons strongly agreed that CDE programs did influence them to adopt Laser dentistry as shown in **Graph 2b**. As shown in **Graph 2c**, dental surgeons unanimously responded that more information about Laser dentistry should be provided in the formal curriculum of graduation and post-graduation studies in dentistry. Only 6% were on the fence about it and 1% disagreed, with no one strongly disagreeing.

Graph 2a: Influence of training on laser usage



Graph 2b: 'Training/educational/CDE programmes can influence or have influenced me as a dental surgeon, to try and adopt to new lasers and technology', your thoughts?

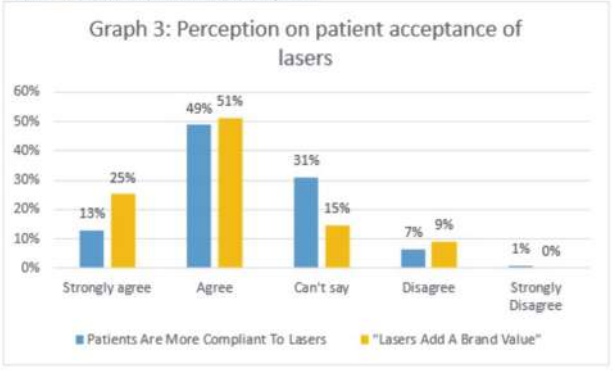
Graph 2c: More information should be provided about dental lasers in BDS/MDS



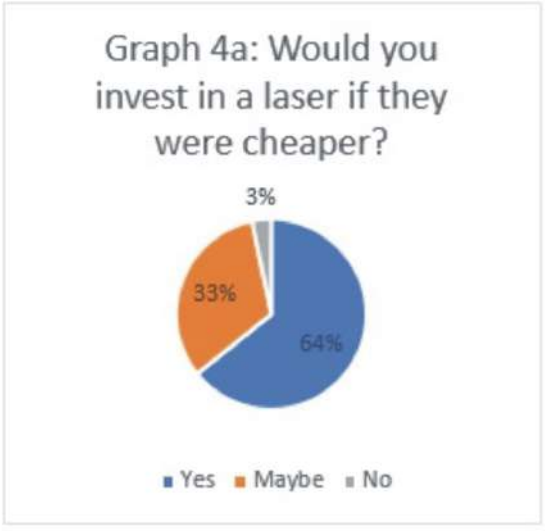
Perception on patient acceptance of Lasers

Graph 3 shows that according to most dental surgeons, patients were more compliant to procedures performed with a Laser rather than those performed with a scalpel or rotary instrument. Out of the 9 dental surgeons who disagreed or strongly disagreed to the statement discussed above, 4 dental surgeons said that patients generally had a negative perception of it being too expensive, 4 dental surgeons said that patients had no negative perceptions or apprehensions, and 1 dental surgeon said that patients found it too intimidating. Most dental surgeons also agreed that dental Lasers added a brand value to their practice. 76% dental surgeons fell on the agreeable side while only 9% fell on the disagreeable side and 15% stayed undecided.

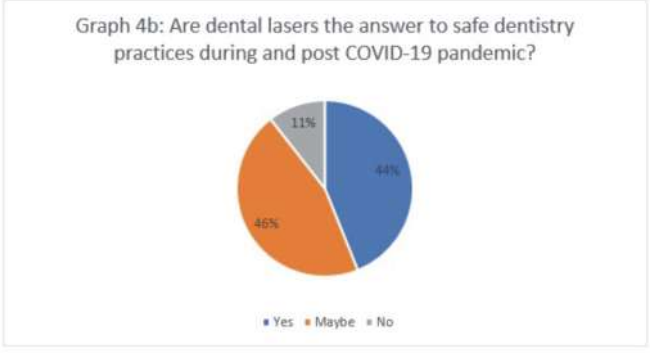
Graph 3: Perception on patient acceptance of lasers



Graph 4a: Would you invest in a laser if they were cheaper?



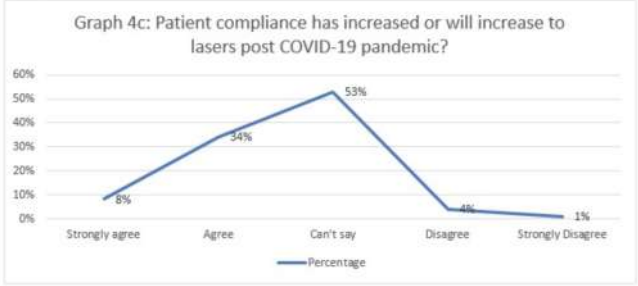
Graph 4b: Are dental lasers the answer to safe dental practices during and post COVID-19 pandemic?



Perception On Laser Usage Post Covid 19

Most dental surgeons (63%) responded that they would invest and adopt dental Lasers into their practice if they were made cheaper **(Graph 4a)**. According to **Graph 4b**, most dental surgeons were still unsure about how safe it was to use dental Lasers during the COVID 19 pandemic. Majority (46%) dental surgeons remained undecided on the safety of using dental Lasers while 44% thought it would be safer as compared to scalpel and rotary instruments. As shown in **Graph 4c**, most dental surgeons (53%) responded that they could not for sure decide if patient compliance for Lasers had increased during COVID. But still 34% dental surgeons, said that patient compliance had or would increase, which was considerably a higher number than 5% who either disagreed or strongly disagreed to the statement discussed.

Graph 4c: Patient compliance has increased or will increase to lasers post COVID-19 pandemic?



Discussion

There is a significant indication to how popular diode Lasers are amongst dental surgeons which can be explained by the various advantages it has over the other Laser systems including: their portable size, more economical price range, and varied applications in multiple dental soft tissue procedures. Diode has a near infrared (NIR) wavelength of 810nm which provides it with the ability to perform various functions like ablation, coagulation, disinfection, haemostasis, reducing post operative edema, decreased scarring, and improved healing with photo biomodulation.[7]

Hard tissue Lasers like Er:YAG and Er, Cr: YSGG lack representation in dental clinics which could be explained by a lack of awareness and high costs as compared to soft tissue Lasers. **Dhayanidhi et al[8],** conducted a study in Coimbatore, India, in which they concluded that while majority dental surgeons are aware of the application of dental Lasers on soft tissues, many are unaware of the hard tissue applications – indirectly indicating the lack of awareness about the hard tissue Lasers.

Along the same lines, Lasers are commonly used for soft tissue procedures due to more awareness about soft tissue application of Lasers and the popularity of diode Lasers amongst the dental surgeons. In the current survey study, it was observed that within periodontics, Lasers are mostly being used for gingivectomy, gingivoplasty, frenectomy, soft tissue crown lengthening, periodontal pocket disinfection, Laser assisted periodontal therapy, peri-implantitis treatment, gingival depigmentation, second stage implant surgery, and more.

Yadav et al.[9] conducted a survey in 2016 assessing the awareness and practice of Lasers amongst dental surgeons in India and found that out of those dental surgeons who used Lasers, majority used it once a month or less. In our study, we found that majority use it weekly. However, keeping biases in mind, a trend can't be accurately established.

Most dental surgeons believed that the biggest hurdle in adopting Laser technology in their practice is high initial purchase cost and the resultant patient un acceptance to pay a higher fee for the treatment.[10] However, **Wigdor et al.[11]**, concluded that overall patients had a positive perception of Laser dentistry; majority would be willing to pay more, and thought that it would be less painful and faster. With high patient acceptance, Lasers can add more brand value to the dental practice.

Another hurdle in acceptance of Lasers by dental surgeons is the inadequate knowledge amongst dental surgeons. Al-Jobair et al.[12]reported that the majority (76%) of final year dental students in a University of Riyadh, Saudi Arabia, had inadequate knowledge of Lasers and its uses in dentistry. **Yadav et al.[9]**summarised that for many students their undergraduate knowledge and experience formed the foundation of their future practice. Hence, inclusion of theoretical and practical training on LaserRs within the undergraduate curriculum might increase its acceptance with time.

During the COVID 19 pandemic, disinfection and sanitation of operative rooms had taken a front seat to minimize transmission of the virus. While dental Lasers don't produce aerosols like conventional rotary instruments, they do produce Laser plume or smoke which contains 95% water and 5% other materials[13]. Viral DNA of HPV has been found in Laserplume.[14] Hence, Laser might not be a safer alternative to conventional rotary instruments. Lack of awareness about this can create a major problem in the future and therefore awareness about safety measures with respect to Lasers should be made a priority by curriculum deciders and course organizers.

Conclusion

Diode type of Lasers are distinctly the most commonly used type of Lasers in dental clinics of Northwest India. Lasers are commonly used for the soft tissue dental procedures rather than the hard tissue procedures. Dental surgeons with apost doctoratedegree working in a government aided dental setup are more likely to be using Lasers in their clinical practice. Dental surgeons using dental Lasers are more likely to keep themselves updated about Lasers and experience no anxiety in operating one. The two major barriers stopping dental surgeons from adopting dental Lasers are lack of training and high costs of Lasers. Dental surgeons unanimously agree that training in the use of dental Lasers should be included in graduation or post graduation studies. Majority dental surgeons agree that dental Lasers add a brand value to their clinical practice and that the patient compliance is higher to Lasers as compared to scalpel or rotary instruments. Dental Lasers produce infectious aerosols in the form of Laser plume and knowledge about it being unsafe is lacking amongst the dental surgeons.

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A Review

Dental Management of Children With Cerebral Palsy, Mental Retardation, Autism & Epilepsy : A Review

Dr. Deepika Sharma[1]
Dr. Ashish Saxena[2]
Dr. Vishal Khandelwal[3]
Dr. Neha Verma[4]

II Year Resident[1]
MDS
Dept. of Pediatric & Preventive Dentistry,
Govt. College of Dentistry, Indore

Professor & Head[2]
MDS
Dept. of Pediatric & Preventive Dentistry,
Govt. College of Dentistry, Indore

Assistant Professor[3]
MDS
Dept. of Pediatric & Preventive Dentistry,
Govt. College of Dentistry, Indore

Lecturer[4]
MDS
Dept. of Prosthodontics, Crown & Bridge
Govt. College of Dentistry, Indore

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Abstract

Children are our future society and assuring their healthy growth and development must be the most important consideration for all. Children with special health care needs (SHCN) have compromised oral health condition as it may be directly or indirectly associated to their disabilities. There is an increased prevalence of gingival diseases and dental caries among Children with SHCN due to poor oral hygiene. Sadly, the significance of dental care for these children has often been missed by the health care workers. The more compromised their general health conditions, the more dental care needs they have. During earlier days, providing basic dental care was the prime concern, but in recent years, the dental profession has emphasized more on complete oral health care to the special health care needs children. Pediatric Dentistry is a specialized branch that provides primary, comprehensive, preventive and therapeutic oral health care to children with Special Health Care Needs.

Children with Special Health Care Needs may experience challenges in many ways such as intellectual disability, physical disability, medical disability, Genetic disability and learning disability. The document addresses intellectually challenged patients including Cerebral Palsy, Mental Retardation, Epilepsy and Autism.

Co-ordination and Consultation with medical and other dental professionals may be required for cautious delivery of oral health care and to enhance long term good results for such patients.

Keywords:

Special Health Care Needs Children, Intellectually challenged, Dental Management of Special Children, Behaviour Management, Oral hygiene.

Introduction

The birth of a child is an occasion of great happiness and joy and is always eagerly awaited by the family members, but when it becomes evident that something is inappropriate with their neonate, their entire world is made into pieces from a whole. The parents of such children start suffering from anger and denial. The child may be nurtured with great love and affection as he grows but, at times, the parents may express their anger on the child who suffers without his own fault. It is difficult to maintain general and oral health of such children and their dentition may be damaged by caries and periodontal diseases. Hence the management of these "God's forgotten children" is a task which needs special effort on the part of the dental surgeon and pediatric dentist[1].

Children with special health care needs are those who have certain disability that restricts them in performing daily life activities. They experience higher health care utilization and expenditures than the average paediatric population. Individuals with special health care needs may be at an increased risk for oral diseases, that can have a direct and devastating impact on the general health of special children[2]. In India about 6-10% of children are born disabled and one-third of the total disabled population is comprised of children[3]. Conditions like Attention Deficit Hyper-activity Disorder(ADHD), Autism, Down's Syndrome, Congenital Heart Disease, Cerebral Palsy, Mental Retardation and Systemic Diseases become a great challenge for the Special health care needs children affecting their overall quality of life so their requirements are also distinctive, and need specialized, multidisciplinary approach for their oral health care[4-6].

The American Academy of Paediatric Dentistry (AAPD) accepted that delivering primary, comprehensive, preventive and therapeutic oral health care to children with special health care needs is a crucial part in the

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speciality of paediatric dentistry. We should consider the unique qualities of each person and the need to ensure maximum health for all, regardless of developmental disability or other special health care needs.

Special Health Care Needs (AAPD, 2013)[7]

Defined as "any physical, developmental, mental, sensory, behavioural, cognitive, or emotional impairment or limiting condition that requires medical management, health care intervention, and/or use of specialized services or programs". This condition sometimes imposes limitations in performing daily self-maintenance activities, can be because of or substantial limitations in a major life activity.

Common Oral Health Problems in Special Needs Care Children

Special health care needs children commonly experiences the following oral health problems : Delayed, accelerated or inconsistent tooth eruption, Dental caries, Periodontal disease, Malocclusion, Abnormal oral habits, Tooth anomalies, Trauma and injury, Enamel hypoplasia, Dental erosion and behaviour problems. There are also some **contributing factors to oral health problems in children with special needs care such as** Genetic disorders, Reduced salivary flow, Antiepileptic Drugs, Physical limitations, Diet restriction and Difficulty in brushing and flossing[4].

Design of Dental Office

One of the first prerequisite in managing a disabled child is accessibility of dental offices. It needs foundation of barrier-free facilities for people with all kinds of disabilities.

Figure 1 :-Dental clinic design for children with special health care needs - 1. Dental chair. 2. Papoose board, 3. Nitrous oxide inhalation sedation apparatus, 4. Wheelchair, 5. Doctor's chair, 6. Assistant's stool[1].

The width of doorways should be more i.e. should be 32 inch wider than normal. Providing wheelchair turning space, design of operatory should allow movement of dental chair, instrument control unit and suction system. To match the wheelchair design dental chairs should be adjustable. Parking lot, Walk away, Entrance door steps/ ground level, Railing 1:12, Floor of the entrance (non slipping), Entrance calling bell, Space for wheelchair and transportation, Telephone, Rest room, Space in the operatory, Mobile units, and mobile dental services should be there.

Protective Stabilization

There is difficulty in controlling extremities of infants or patients with certain neuromuscular disorders so partial or complete protective stabilization of such patients becomes necessary and also effectively supports in diagnosing and delivering dental care[8].

Part immobilized	Name
Body	Triangular sheet, Papoose board, Pedi-wrap, Beanbag dental chair insert Safety belt & Extra assistant
Extremities	Posey straps, Velcro straps, Towel and tape and Extra assistant
Head	Forearm body support, Head positioner, Plastic bowl and Extra assistant
Intraoral	Molt's mouth prop, Mckesson bite blocks, Wrapped tongue blades & Open wide disposable mouth prop

Table 1 : Classification of specialized equipments[9].

Children with Special Health Care Needs may experience challenges in many ways. Disabilities include intellectual disability, physical disability, medical disability, Genetic disability and learning disability.

Dental Management of Intellectually Challenged Children

Intellectual challenges include Cerebral Palsy, Mental Retardation, Epilepsy and Autism.

Cerebral Palsy

Is one of the most severely handicapping condition affecting approximately 2-2.5 per 1000 live births. It is a disorder of posture and movement caused due to non-progressive abnormality of the immature brain that originates during the prenatal or perinatal period and results in significant impairment of functional mobility[7]. Oral manifestations include loss of tooth structure due to GERD, Gingival hyperplasia because of long term medication, frequent tongue thrust during speaking, malaligned anteriors, jaw dislocation is common due to abrupt opening of the mouth.

During dental examination or treatment of children with CP schedule appointments early mornings. Obtain medical records prior to the first appointment, and arrange necessary consultation. An extensive oral examination should be completed on all patients. If the patient is unable to provide accurate information, may require help of family members. The dental treatment plan should be formulated according to accepted dental practice and take into consideration the following factors: Mental age of the patient, Understanding and communication level, Psychological needs, Physical limitations, Accessibility issues, Medical conditions, Antibiotic prophylaxis[1].

Use behaviour management technique to obtain desired behaviour such as voice control tell-show-do(TSD), modelling. In case of severely affected child verbal command should be repeated. As these patients have severe gag reflex there may be difficulty in taking dental radiographs. Extra oral techniques such as **oblique head plate** and **reverse bitewing technique can be used in such patients**. When molars are involved, prefer placing stainless steel crowns over restorations. Myofunctional therapy should be incorporated during the growing years of the child because it strengthens the facial muscles and turns the inactive lip into active one. It also prevents flaring and malocclusion as it keep the tongue at its place. The dentist should Counsel the parents regarding oral hygiene maintenance, growth and development of orofacial disparity occurring due to such condition. Emphasize the importance of diet and Preventive treatment modalities like topical fluoride application and significance of recall appointments [10].

Adjust the Dental chair carefully and slightly tip the chair back to provide a position of security. There is severe head- and-neck involvement in spastic type of a patient so they require more control and support, are suggested to sit on the parent's or assistant's knee, leaning back against the right shoulder. If the patient is on a wheelchair, the treat him/her in the wheelchair itself. Head stability can be achieved by the help of Velcro straps, and open mouth can be maintained with the use of mouth props. To restrain the arms and legs Canvas straps equipped with Velcro fasteners can be used. A dentist should avoid unexpected movements which may trigger muscle spasm. He should be gentle and caring.

Malocclusion is quite severe in CP patients. There is a risk of caries and enamel hypoplasia so Orthodontic treatment may not be a treatment option. The success of orthodontic treatment actually depends on the potential of the patient or the caretaker to maintain good daily oral hygiene. Now a days, certain technological advancements are done in dentistry which could help disabled dental patients for their orthodontic treatment. They include taking impressions using quickset materials, use of self-etching bonding agent, self-ligating brackets, and use of reversible mini-implant anchorage. Orthodontic treatment become less difficult in CP children after careful patient selection. Success of the treatment depends on type and severity of malocclusion and the amount of patient cooperation.

In CP patients, there is an increase risk of dental trauma as there is uncontrolled head movement. Thus, lip seal acts as a barrier. The prevention of future trauma and the treatment of traumatized teeth should be of primary concern. A pedodontist should educate the parents, caregivers and teachers regarding correct emergency care of CP patients after trauma, to look for preventive measures, like cautious transfer of patients in wheelchairs, use of mouth guards, padding of objects and hard surfaces, and Also highlight the emergency measures to caregivers in dental trauma and explain the steps to follow if a permanent tooth is knocked out. Suggest a tooth-saving. Also, instruct caregivers to find any missing pieces of a fractured tooth. Also explain them that in case of foreign body aspiration patient's chest x-ray is essential. Children with developmental disabilities are found to be more physically abused as compared to general population. In case of any suspect of child abuse come across, contact Child Protective Services agency immediately.

One of the most common finding in CP patient is Bruxism. If it is severe and constant may cause premature wearing of the teeth. The treatment options for Bruxism includes restorations, occlusal adjustments, use of oral splints, extraction, and pharmacological management. In patients with severe visual impairment Sleep disorders may also predispose to the development of nocturnal bruxism. Before suggesting mouth guards or bite splints in CP patients Gagging problems must be observed as it may make them uncomfortable and will not wear them. Features such as hypotonia and open bite causes drooling which affects daily oral care.

Periodontal disease is also common in children with CP. Major factor contributing periodontal disease is because of antiepileptic drugs, most commonly phenytoin. Gingival hyperplasia is predictive for periodontal diseases. The pedodontist should teach caregivers about oral hygiene and demonstrate proper brushing techniques to them. An antimicrobial agent such as chlorhexidine is recommended for daily use. Patient with swallowing problems, faces difficulty in mouth rinse so chlorhexidine can be applied using a spray bottle or toothbrush and is equally effective as rinsing.

Because of inadequate oral hygiene Dental caries is frequent among CP patient. Factors contributing to the development of dental caries are biological, economic, cultural, environmental, and social factors. The dentist should guide the caretaker to make a patient drink water regularly, give sugar-free medicines if possible, and rinse mouth after taking any medicine also to provide substitute to cariogenic foods and beverages. Preventive measures such as fluorides and pit and fissure sealants should be recommended.

Dental erosion is commonly seen in CP patient generally who are predisposed to GERD. By diagnosing early signs of dental erosion in CP patients, the Dentists can provide proper preventive therapy and can refer the patient for treatment of GERD. Diagnosis of early signs help in preventing irreversible damage to dentition. The dentist should teach the parents or caregivers

correct tooth brushing techniques. Horizontal scrub method is the most common technique recommended as it is quite easy to perform and can give good results. Electric toothbrushes have also been recommended for disabled children. Parents or caregiver should always help the child to brush their teeth, and the child's head must always be supported. There is presence of sucrose in almost all of the medications which are prescribed to children. Thus, a child on oral medications must get their teeth cleansed after each medication[11-13].

It may be difficult to manage CP patient at times, in such cases sedation and anesthesia is needed. Most commonly if invasive procedures are required[14,15]. Patients with history of respiratory problems and convulsions represent a specific challenge so prior to the required procedure, evaluation by the related specialty (pediatrics, anesthesia, and/or neurology) is often needed. If the procedure involves prolonged period of decreased oral intake, oral medications can be replaced by intravenous antiepileptic drugs.Drugs which can be used are phenobarbitone or phenytoin, anyhow, a loading dose should be initiated before the procedure for optimal effects. Once the patient is able to take the oral drugs, discourage IV drugs quickly. Drugs like benzodiazepines, nitrous oxide, narcotics, and propofol can be used to induce sedation and anesthesia. Many children with severe mental disability are not able to tolerate initial facemask prior to IV sedation. But can be utilized in milder cases to avoid the fear and anxiety corresponding to IV insertion. The airway should be maintained throughout the procedure and Oxygen saturation should be monitored by pulse oximetry.

CP children are at higher risk of aspirating dental filling materials, debris from tooth preparation, or sometimes an extracted tooth. This is because of increased salivation and water spray used for cooling instruments. In these cases a throat shield should always be used to further protect the airway. Postoperative care involves keep the child restrained until he or she is able to respond to verbal commands or gets complete consciousness. IV cannulas and monitor should be removed as soon as possible as they add to the child's fear and anxiety.

Mental Retardation

Also called as intellectual development disorder (IDD) or general learning disability[16]. Characterized by remarkable restrictions both in intellectual functioning like learning, reasoning, problem solving and in adaptive behaviour. **Oral manifestations** like Nursing bottle caries or ECC, Altered salivary flow due to multiple medications, malocclusions, fractured non vital teeth and soft tissue complications[1]. Early loss of tooth structure, secondary caries, trauma and habits leads to speech impairment. Loss of space for the permanent dentition causing significant orthodontic problems, abnormal jaw development, change in mastication, affecting esthetics and a development of poor self-image and Halitosis.

Behavioural problems are one of the main barriers for individuals with special needs in accessing dental care and frequently represent a challenge for oral healthcare practitioner[17]. **Desensitization** may be fruitful with some anxious patients. It should be the induction therapy. The first visit can be an introductory visit in which no actual treatment has to be done.While administering dental treatment to patients with disabilities the use of restraints is appreciated as acceptable dental practice when properly applied to control behaviour but it should be adopted only when there is failure of other techniques such as desensitization, TSD, etc. after taking an informed consent.

Those patients who cannot be managed with physical and chemical restraints are the optimal for the sedation procedure. Sedation and consulted behaviour management should be given with patient's physician, family and caregiver's consent .**Oral sedation** with Valium, Xanax, chloral hydrate, or hydroxyzine may be helpful in reducing patient anxiety during dental treatment. Good team and appropriate monitoring equipment**s are** required for Intravenous sedation. The team must be well trained to respond to emergencies such as allergic, respiratory, and/or cardiac complications. General anesthesia should be the last resort in behaviour management. The treatment is advised for the non co-operative children or children who are too young to comprehend. The medical condition should be examined by the pediatrician and anesthetic before the child can be considered for the anesthesia.

Notice their brushing method first and demonstrate them the correct technique. A powered tooth brush can also be introduced in this situation. Reinforce the techniques to caregiver. Choose appropriate method as gargles in case of use of mouthwash. Patients with impaired swallowing reflex, spray works well. Along with restorative care, stress should be made on decreasing the occurrence of new caries in these patients by promoting non-cariogenic food and beverages as snacks and adding more water to their diet. Dentist should explain sugar free medicine and importance of rinsing with water after every meal and medications.

MR patients come across traumatic injuries very frequently; educate parent and caregiver with emergency management of knocked out or fractured tooth along with tooth preservation and instant professional care. Find out the mental, dental and skeletal age of the child and clinically correlate the dentition. For any congenitally nursing teeth, hypoplasia or developmental defects keep the child under observation. The occurrence of all these defects helps in determining if the patient has multiple problems or is syndromic MR.

An orthopantomogram (OPG) can be very beneficial because it is non invasive procedure and it's elaborate image covers complete dentition. Due to various drugs gingival overgrowth can occur, if the gingival tissues interfere with occlusion or oral hygieneGingivectomymay be done. Electrosurgery or laser surgery techniques should also be viewed as an alternative in those patients who cannot tolerate periodontal packs well. Frequent recall visits are indicated (every 2-3 months) in these patients due to poor oral hygiene.

Glass ionomer cement releases fluoride so it is considered as more appropriate restoration for patients with a high caries. For restoring severely damaged teeth Stainless steel crowns are recommended. When the patient can cooperate tooth is restorable then Endodontic treatment should be considered. Single-appointment procedures are advisable. Use of an apex locator would be helpful as working-length radiographs would be tough to obtain,. Fixed prosthodontics is preferred over removable if patient's oral compliance is present. For tooth preparation resin bonded bridges are more helpful and less time- consuming. Complete dentures are contraindicated in severe and profound MR and patients with poor muscle control.

Epilepsy

It is a group of disorders characterized by chronic, recurrent and paroxysmal changes in neurological function caused by abnormalities in the electrical activity of the brain. Each episode of neurologic dysfunction is called a seizure and the seizure may be convulsive when accompanied by motor manifestations or may be manifested by other changes in neurologic function**. Oral manifestations**include Gingival hyperplasia, Recurrent aphthous ulcers, Anomalous dental development like small teeth, delayed eruption, Cervical lymphadenopathy, Soft tissue lacerations of tongue or buccal mucosa, Trauma to teeth-avulsion, luxation and fractures[18].

Management of seizures in the dental office can be best done by taking complete medical history regarding the type and frequency of seizure episodes before the treatment. Reduce the stress on the patients with psycho behavioural preparations, sedations etc. Since Diazepam has anticonvulsant properties, it is the drug of choice. Use of dental chair light is avoided. Avoid those drugs which promote seizure like phenothiazines, IV local anesthetics. Earlier dilantin sodium has been used for seizures, but nowadays new drugs like vigabatrin, lamotrigine, gabapentin and topiramate are used. Due to the use of antiepileptic medication (dilantin sodium), typical fibrous gingival hyperplasia may occur. Surgical removal may be necessary in certain cases and the child's physician can be consulted about a change in medication.

Appointments should be kept short. Stress the importance of tooth brushing procedures and regular dental review. The fixed type of appliances are preferred if indicated for tooth movement and tooth replacement,. The patient should be placed in the lateral recumbent position and the chair is lowered to a supine position if the seizure occurs in the chair. The patient is protected from injuring himself by moving sharp objects away and do not place anything in the child's mouth during a seizure. The lips can be superficially suctioned to remove excessive secretions, but deep suctioning must be avoided, to prevent a gag-reflex and provocation of emesis.

Support a patent airway. Have supplemental oxygen available to use if needed. If the convulsions do not stop within a five minutes, medication should be administered .This can be rectal diazepam is 0.5 mg/kg upto a maximum of 10 mg. The dose for intranasal midazolam is 0.2 mg/kg up to a maximum of 10 mg. Emergency medical services/ambulance should be activated if rescue medication has been used. Hospital admission via emergency department services should be arranged .Neurologists and paediatricians consent were taken during the entire treatment protocol.

Once the seizure gets over, Do not proceed further with dental treatment that day. The operator should try to talk to the patient to assess the level of consciousness during the post-ictal phase. Do not try to restrain the patient, as he or she might be disoriented. Evaluating the post-ictal phase, discharge the patient home with a responsible person, to his or her physician or to an emergency clinic for further valuation. When Seizure occurs during treatment, remove all dental instruments from the mouth. Clear the area around the dental chair. Turn child to one side and stay with him. Monitor airway to reduce risk of aspiration. Note time seizure begins. If seizure continues> 5 min call EMS-danger of Status Epilepticus (potentially life threatening)[19].

Autism

It is a neuro-developmental disorder characterized by impaired communication and social interaction skills and repetitive and restricted behaviour and interests. It is called autism spectrum disorder since the manifestations of the disorder vary greatly amongst individual patients. **Oral manifestations include**Dental caries due to soft and sweetened foods and also pouching due to poor tongue co-ordination, difficulty in tooth brushing and flossing, Bruxism, tongue thrusting, picking at gingiva and lip biting which might account for the high rate of self-inflicted oral lesions.

The prevalence of traumatic teeth is higher among children with autism due to self-injury from head banging, picking or face tapping. Gingivitis and poor oral hygiene. The study 'Dental caries experience, oral health status and treatment needs of dental patients with autism' finds that autistic children exhibit poor oral hygiene, higher caries prevalence and unmet requirement for dental treatment as compared to non-autistic healthy children. Therefore those oral health program that stresses on prevention, should be appreciated and considered of great importance for autistic children and young people[20].

Many of the drugs used to treat the associated features of autism have systemic side effects like CNS stimulants (methylphenidate, dextroamphetamine) - causes xerostomia and hypertensive episode also may occur if local anaesthetics with vasoconstrictors are given in excess or by inadvertent intravascular injections. Anticonvulsants (Carbamazepine and valproate) - When given along with aspirin and other non-steroidal anti-inflammatory drugs, excessive bleeding may result. Erythromycin and clarithromycin may cause carbamazepine toxicity by inhibiting its metabolism in liver. Antipsychotic medications (Risperidone and olanzapine) - May induce motor disturbances affecting speech, swallowing and the use of removable prostheses, produce transient sialorrhea followed by xerostomia. Antidepressants (Fluoxetine and sertraline) - Xerostomia, dysgeusia (altered taste sensations), stomatitis and glossitis. Fluoxetine comes with a risk of developing involuntary orofacial movements, like sucking, smacking and protrusion of tongue.

For the dental treatment of an autistic patient several basic behaviour guidance methods have been suggested, which includes the presence of parents, tell-show-do technique, short, clear, and differential verbal commands. Visual pedagogy concept or combined use of shaping, reinforcement and sensory adaptation can also contribute in dental examination of the autistic child. Child with limited receptive skills and absence of joint attention, the use of reward statements may not provide the desired results during dental treatment. Younger autistic patient may behave better to certain management techniques like positive reinforcement. Therefore, there is a critical influence of child's age on social skills and in handling their behaviour.

Visual pedagogy that arouse aversive behaviour of the child may helpful in setting up favourable conditions for him or her to cooperate during dental treatment. The process known as functional behavioural assessment may take place during the pre-visit consultation of parents. To get the child familiarized with the dental operatory room, the dentist can arrange the home-centered preparation including acclimatization with dental instruments, educating skills essential for the dental examination by utilizing phrases such as 'open your mouth', and preparing custom-made photo books to help the child. The latter model takes advantage of the ability of children to make better contact by means of pictures instead of words[21-23] .Video modelling is an effective method for developing various skills in children with autism such as social, communication and self-help skills.

Application of the TEACCH (Treatment and Education of Autistic and related Communication –handicapped children) concept to desensitize the children to dental procedures and oral hygiene procedures are usually effective in training the children in home and in clinic. The acceptance of toothbrush by the child can be increased by a kind introduction to tooth brushing using alternatives like washcloth, toothbrushes of various texture and design may upgrade. Children with severe bruxism and self-injurious habits prescribe mouth guard. Powered toothbrushes are recommended only when the child can tolerate[24].

To calm the child papoose Board or Pedi-wrap and pre appointment conscious sedation may be important. Ask the child to sit alone in the dental chair and make him familiar with the dental setting. Approach the child in a quiet, nonthreatening manner. Eye contact is difficult to achieve and the children are prone to tantrums and aggressive or destructive behaviour. Using fingers, start the oral examination slowly and if successful, begin with dental instrument.

Do not make dental instruments visible to the child and also keep light out of the child's eyes. Reduce other sensory input such as loud noises, sudden movements and odours that may be distracting to the child. Reward co-operative behaviour with positive verbal reinforcement. Notice abnormal body movements and predict further movements. Keep area around the dental chair clear. Use the same staff at each visit if possible. Sedation must be used with accurate precautions and after physician consultation. Giving treatment in the operating room by using general anesthesia for complex surgical or restorative treatment is considered only if all other approaches fail.

Recent Advancements

Now a days many technological advancements have been achieved in the field of dental management of special children which have proven to refine skills and can be integrated by the pediatric dentists in their day-to-day clinical practice for successful dental treatment in this group of patients. Audio and video technologies have been shown good results in managing children with special healthcare needs. Computers inspire autistic children due to their predictability and steadiness as compared to uncertain human responses. The computer provides the child his/her independent functioning skills. Furthermore, smartphones and tablets are creating their way into clinical practice because of their many advantages.

Conclusion

The attitude and skills of dentists is the most important aspect for successful treatment of children with SHCN. Oral health is progressively considered as a foundation for general health, and a foremost indicator for the success of dental treatment. The parents, caregivers and teachers for children with special health care needs must become learned and competent in home oral health care. The role of the pediatric dentist is to enhance oral health and to motivate parents and caregivers for good home oral health practice. When a child with health care needs reach adulthood, his or her oral health care requirement may increase beyond the scope of the pediatric dentist's practice. The victorious transformation from pediatric to adult dental care is essential for the continuity of care and improvement in long- term prognosis of children with SHCN.

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A Review

Minimal Invasive Dentistry: A Review

Dr. Sachin Parmar[1]
Dr. Ashish Saxena[2]
Dr. Shikhar Pratap Chauhan[3]
Dr. Ajay Parihar[4]

II year Resident[1]
MDS
Dept. of Pediatric & Preventive Dentistry,
Govt. College of Dentistry, Indore

Professor & Head[2]
MDS
Dept. of Pediatric & Preventive Dentistry,
Govt. College of Dentistry, Indore

Assistant Professor[3]
MDS
Dept. of Pediatric & Preventive Dentistry,
Govt. College of Dentistry, Indore

Professor & Head[4]
MDS
Dept. of Prosthodontics, Crown & Bridge
Govt. College of Dentistry, Indore

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Abstract

Minimally invasive procedures are the new model in health care. Minimally invasive dentistry acquire philosophy of prevention, remineralisation and minimal intervention for the placement of restoration and replacement of faulty restorations. Minimally Invasive Dentistry (MID)deals with removal of the minimal amount of healthy tissues with least invasive surgical approach. At microscopic level it embraces the art of detecting, diagnosing, intercepting and treating dental caries.

This technique has evolved from an improved understanding of the caries process and the evolution of adhesive and biomimetic restorative materials. MID consider dental caries as an infectious condition rather than an end product of it. Now "extension for prevention" is no longer practiced but has changed to "constriction with conviction."This paper reviews in brief the concept of minimal intervention in dentistry.

Keywords: ART, Minimal Invasive Dentistry,Cariology, Air abrasion,Chemomechanical caries removal, Remineralisation.

Introduction

Preserving the sound set of natural teeth for each patient should be the purpose of every dentist. Whole method in the field of health is aimed basically at conservation of the human body and its function. Miles Markley, summarized in his statement the central concept in the modern approach to the dentist's role in the treatment of dental caries: that the loss of even a part of a human dentition should be given utmost importance just like **"a serious injury,"** and that dentistry's goal should be to preserve healthy, natural tooth structure. His words are more pertinent in todays era than when he wrote them almost half a century ago.

Earlier, dentistry's attitude in treating dental caries has been surgical i.e. excavating carious tissue and restoration with suitable material. With time, contemporary dentistry has progress to a minimally invasive approach, in which caries is managed as an infectious disease, deferring operative intervention as long as possible. The prime target is maximum conservation of demineralized, noncavitated enamel and dentin. Minimally invasive dentistry acquire philosophy of prevention, remineralisation and minimal intervention for the placement of restoration and replacement of faulty restorations. MID expresses very precise excision of what has to be excavated, without causing any damage to adjacent healthy tissue.[1]

Historical background

Evidence shows that ancient culture used trephines, drills, files, and other suitable devices to prepare ornamental cavities in teeth for beauty purpose. In early 17th century, hand-operated instruments having rotating drill were used to make ornamental cavities in decayed teeth.

G.V. Black was the first dentist to propose treating dental caries using minimal intervention in 1800's. Till that time clinical symptoms were addressed by tooth extraction or restoration. Restorations of that time used an alloy that corroded rapidly and later expand. Buonocore In 1955, described a new approach for etching enamel surfaces to make them retentive for a restoration. In 1960's, the researchers dedicated their expertise in better understanding dental caries and assumption of its relationship to fluoride.[2]Bowen in 1962 invented an adhesive materials, which lead to the invention of minimal invasive prevention.

Use of silver diamine fluoride(SDF) as a minimal invasive approach in dentistry was early in 1970s. Soon after, many more innovative procedures came forth with the objective of caries prevention. At around 1980, a new technique of preventive resin restoration(PRR) was developed, which was followed by introduction of a traumatic restorative treatment (ART) in 1980s. Different chemo-mechanical caries removal concepts were also introduced in the 1990s. In 1997, it was believed that assessment of carious lesion development and progression played a vital part in provision of adequate oral health.

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The first International Association for Dental Research (IADR) symposium on minimal intervention techniques for dental caries was organised at 73rd IADR congress in Singapore in 1995 and was almost entirelyfocused on Atraumatic Restorative Treatment (ART). Which was one of the minimal invasive approach.[3]

Objectives of MID

Minimally invasive dentistry requires a change in approach to managing dental caries. Dental caries needs to be considered as a bacterial disease rather than the end product of that disease.The prime objectives of MID helps in suppressing the bacteria, limiting the substrate upon which they survive and its duration in the mouth, enhancing the oral environment (increasing saliva and its minerals), and protecting the teeth with fluoride and sealants in addition to the usual oral hygiene methods.

Following are the objectives of minimal invasive dentistry

1. Identification of disease causing factors by evaluation of saliva, which includes salivary flow rate, salivary pH, concentration of bicarbonates in saliva and its viscosity[4]. Evaluation of caries activity with the help of various caries activity test[5]. Assessing occlusion and other tooth factors such as heredity pattern, systemic condition like xerostomia and vitaminor protein deficiency. Understanding patient environment like their socioeconomic condition, education level, monthly income as all these factors are associated with the prevalence of dental caries. Frequency of diet and the type of diet areassociated with caries progression hence analysing patients diet with the help of diet chart followed by diet counselling is necessary.
2. Prevention of disease by combating caries inducing microorganism with the help of Bisguanides (chlorhexidine) and triclosan. Modifying caries promoting ingredients & use of sugar substitutes (Xylitol). Increasing resistance of teeth to decay with the help of topical fluoride, pit and fissure sealant and remineralising agents such as amorphous calcium phosphate.
3. Control of disease by either reducing the attacking forces such as removing dental plaque, altering the plaque microflora and by reducing dietary sugar to reduce acid production or enhancing the host resistance by use of preventive fluoride application and by using various remineralizing agents.

Principles of MID

The core principles of minimal invasive dentistry are as follow:-

- Early detection of lesion and disease control through reduction of cariogenic flora.
- Remineralization of early lesions.
- Minimal surgical intervention of caries lesions.
- Repair of faulty restoration rather than a replacement.
- Examining restorations.

Basic approaches to minimal invasive dentistry

Use of Fluoride for Preventing Dental Caries

The discovery of fluoride in dentistry (1901) has revolutionized treatment modalities with a new aspect of prevention and conservation of tooth structure coming into foreplay. Since then, there has been a lot of research on both topical and systemic fluoridation in an overzealous attempt to control the most debilitating dental problem of caries.various forms of fluoride are available which are classified as self-applied and professionally applied. Self-applied topical fluorides include toothpastes, mouth rinses, and gels. Professionally applied topical fluorides include higher-strength rinses, gels, and foams; fluoride varnishes; and silver diamine fluoride.

Although topical fluoride is still being widely used as a preventive measure for dental caries, systemic administration of the same has gained major criticism worldwide due to the low margin of safety of fluoride and no control over the amount of individual intake when administered on a community level.

Application of Silver Diammine Fluoride

Silver diamine fluoride (SDF) was first investigated as a part of Mizuho Nishino, phd's thesis at Osaka University in Japan in 1969. It is a colourless, clear liquid that combine both the antibacterial effects of silver and the remineralizing property of fluoride ion, it is a promising therapeutic agent for managing carious lesions in young children and in those with special care needs. Various in vitro studies has shown its effectiveness in reducing specific cariogenic bacteria.[6]

The fluoride component provide strength to the tooth structure for attack by the acid byproduct of microbial metabolism, reducing its solubility and interfere with the biofilm. killing bacteria which are responsible for local environmental imbalance that demineralizes dental tissues.[7]The only apparent drawback is that as the caries lesions become arrested, the precipitation of silver byproducts in the dental tissues stain the lesions black, which is unaesthetic in visible areas.[8]

Preventive Resin Restoration(PRR)

With the advent of newer restorative materials the ideology of sealing for prevention of fissure caries came into practice. Due to superior wear resistance and mechanical properties, composite resin materials are the material of choice rather than glass ionomer for the treatment of early occlusal caries in permanent teeth. PRR is the invasive and noninvasive treatment of borderline or questionable caries. PRRs were first described by Simonsen and Stallard in 1977.[9]The resin placed in the carious areas and adjacent caries susceptible areas, seals them from the oral environment.

Atraumatic Restorative Treatment (ART)

Atraumatic Restorative Treatment (ART) was initially developed as a new treatment method for carious restoration in developing countries where definitive treatment is difficult due to lack of resources.The ART was started way back in Tanzania in the mid 1980s which was then followed by several community field trials conducted in Thailand and Zimbabwe in 1991 and 1993 respectively. The American Academy of Paediatric Dentistry (AAPD) defines ART as "a dental caries treatment procedure involving the removal of soft, demineralized tooth tissue using hand instrument alone, followed byadhesive restorative material, which is routinely glass ionomer cement".[10]

The fluoride ion released from the GIC initiate the fluorapatite crystal formation, which is more acid-resistant, making the tooth less vulnerable to caries. GIC can be recharged and may acts as a reservoir of fluoride ions taken up from topical fluoride applications. Recently, the use of SDF with ART has been initiated known as Silver Modified Atraumatic Restorative Technique (SMART). Drawback associated with ART include lack of its wear resistance, marginal gaps, and loss of restorations. Many attempts have been made to refine the effectiveness of ART with the addition of antimicrobial agents. CHX was added to GIC which reduce the number of residual bacteria remaining in the cavity after the removal of infected tissue.Various research and meta analyses shown that Success rates for ART restorations depend on the material used, training of the operator, and extent of caries.[11-14]

Pit and Fissure Sealants

Protecting the natural pits and fissures of newly erupted teeth from dental decay is not a new concept. There have been numerous references to reducing the decay susceptibility of pits and fissures since 1923 when H. T. Hyatt suggested a technique called prophylactic odontonomy. in 1983 the National Institutes of Health published a report entitled, “Consensus Development Conference Statement on Dental Sealants in the Prevention of Tooth Decay.” This report recommended the use of pit and fissure sealants as a safe and effective method of preventing pit and fissure decay.

Sandwich technique

In this technique composite resin is bonded over GIC. It is mainly done in conditions where occlusal load is more and there is lack of enamel to provide adhesion to composite resin. It takes advantage of strong adhesion of GIC to tooth structure and superior physical properties of resin-based composite.

It involves placement of Resin Modified Glass Ionomer Cement (RMGI) at the base of the prepared cavity, followed by curing and the addition of composite restoratives to complete the restoration. Mainly there are two type of sandwich technique i.e. closed sandwich technique (If the remaining layers of composite resin completely encase the RMGI), open sandwich technique(If the RMGI is exposed to the oral environment at the base of the restoration).

The sandwich technique has been introduced since 40 years, It is commonly practiced among permanent teeth; however, there are very few studies done on use of sandwich technique in primary teeth.[15]A study done by Cannon ML in 2003 for evaluation of the clinical efficacy of the open sandwich technique in pediatric dental practice concluded that open sandwich technique can be successfully practiced in primary teeth.[16]

Hall technique

Another minimally invasive restoration therapy introduced especially for deciduous teeth that may be helpful in reducing the treatment burden of cavitated carious lesions in dentine is the Hall technique. The Hall technique is one of the methodsfor sealing in caries in primary molars.[17]The Hall technique using preformed metal crowns (PMCs) was pioneered in the literature in 2006 by Scotish Dr. Norna Hall.

In this technique, the crown is placed without caries removal, or tooth preparation and without giving local anesthesia. Instead an appropriate size of PMC is selected and filled with glass ionomer cement. The crown is then fitted over the carious primary molar using finger pressure, or by simply asking child to bite over it.[18]

The Hall technique has very straightforward biological principles. It protect the primary tooth until shedding by arresting carious progression. Mechanism behind Hall technique is that the superficial plaque layer is left and sealed along with carious lesion, which is the most essential layer in the biofilm for caries progression. As a response, the plaque biofilm composition will be shifted to a less cariogenic microflora, which in turn arrest or slows down the caries progression in primary teeth.[19]

Chemicomechanical caries excavation

The procedure involves application of chemical agent on carious dentin, which acts on pre-degraded collagen fibres of outer infected and non remineralizable dentin and promotes its softening. Subsequently, soft carious tissue is removed by gentle excavation (mechanical action) without affecting the healthy tissues.Various chemomechanical caries removal systems are used like: Caridex, Carisolv, Papacarie and CarieCare. They are sodium hypochlorite-based or Papain enzyme based agents.

Ozone Therapy

Ozone is a powerful oxidizer which effectively kills bacteria, fungi, viruses and parasites at very low concentration. It readily penetrates through decayed dental tissue, eliminating the ecological niche of cariogenic microorganisms and breaks up the acidic products of cariogenic bacteria. It is expected that 'clean' lesion can remineralize with aid of topically applied remineralizing agents. Once ozone treatment of the carious lesion is completed a remineraling solution containing 2% sodium fluoride and 5% xylitol is applied to promote healing of the caries lesion.[20] This simple and fast approach avoids the need for administration of local anaesthesia, drilling and filling, however, its application is restricted to treat superficial enamel lesions and root caries only.

Resin Infiltration Technique

Resin infiltration or caries infiltration is an innovative approach primarily to arrest the progression of non-cavitated white spot lesions, non-cavitated interproximal caries lesions, or incipient proximal lesions, with a light curable resin.[21, 22] The infiltrating resin not require any shade matching due to its high refractive index which produces a chameleon effect. It works on capillary action; a low viscosity resin is drawn deep into lesion. The resin fills the pores system and block further passage of nutrient into pores within the tooth, which ultimately block the carious progression. Also it maintain the anatomical shape of tooth by replacing lost tooth structure. The lesions change their optical properties and appear similar to sound enamel.

MID in Pediatric Dentistry

MID approach to keep the teeth functional throughout the life and it is applicable to every dental specialty, particularly in paediatric dentistry. It is difficult to provide oral care to a young patient while ignoring the concepts of MID. Besides all the benefits in terms of tooth tissue preservation, MID is considered a friendly approach, which reduces patient anxiety and offer health-oriented treatment options.

The implementation of topical fluoride therapies like fluoride varnish, fluoride gel and fluoridated mouth rinses – in combination with fluoridated toothpaste was shown to have an added caries reduction effect. A personalised treatment plan, considering the child Caries Risk Assessment (CRA), will assist the professional in deciding whether and which of these therapies are needed.

Recent Advancement in MID

The preventive aspect includes numerous remineralizing agents, such as fluorides, xylitol, nanohydroxyapatite, and other calcium and phosphate based remineralizing agents; however, in order to achieve a biomimetic remineralization,use of remineralizing agents such as calciumphosphate and Bioactive Glassappear in the preventive field.

Casein phosphopeptide– amorphous calcium phosphate complex (CPP-ACP) is a calcium phosphate complex made up of casein phosphopeptide and amorphous calcium phosphate. CPP casein has the unique ability to adapt to an acid-base environment. At an acidic Ph, this ACP get separates from CPP, which result in increased calcium and phosphate levels in saliva which maintenance the state of supersaturation. The CPP-ACP complexes have been shown to prevent demineralization and enhance remineralization in the presence of fluoride.[23]

Glycine- guided remineralization mimics the natural biomineralization process, which results in the formation of well-oriented rod-like hydroxyapatite crystals that restore the mechanical properties of demineralized enamel.

Novamin's chemical name is calcium sodium phosphosilicate. It's a bioactive glass which is made up of minerals which are present in the human body. It responds when comes into contact with saliva, water, or other bodily fluids. This formula is used in varnish, toothpaste, and root desensitizer products, and it is available in varnish, toothpaste, and root desensitizer form.[24]

Tri calcium phosphate (TCP) has the chemical formula $Ca_3(PO_4)_2$ and comes in alpha and beta forms. In an aqueous oral setting, it is relatively insoluble. The organic coating prevents fluoride interactions, but it dissolves as particles come into contact with saliva.

Smartburs®- These are the polymer burs which when approaches the sound dentin, they self-limit, hence they retain the sound tooth structure. That's why they are also referred to as "dentin protected." For selective dentine caries elimination, smart-prep polymer burs are a relatively new and naval launch.

Sonicflex system- The sonic oscillating, SONIC flex system (KaVo Dental) was developed to finish mild to moderate proximal cavities. This system uses highly frequent oscillating preparation instruments in an air-driven oscillating hand piece (Airscaler, SONICflex 2003, KaVo Dental). It minimize the damage to neighbouring teeth during proximal preparation and finishing.

Air abrasion excavation (kinetic system)- Air abrasion is also referred to as advanced particle beam/or micro-abrasive technology. Kinetic cavity preparation (KCP) is a technique, which uses fine particles of powder fired at high speed in a controlled manner instead of the traditional high and low speed drills. Quantity of tooth removal and depth of penetration depends on air pressure, particle size, and nozzle diameter of the hand piece, distance and time of exposure to the object.[25]

Dental caries vaccine- Vaccines are immunobiological substances which are designed to develop specific protection against any given disease.[26]vaccines act by stimulation for the production of a protective antibody and other immune mechanisms. Vaccines are mainly prepared either from live-modified organisms , nonvital organism, cellular extract, toxoids, or by fusion of these substances. Caries vaccine are specially designed to play protective part against dental caries. Its very well known that S. mutans is main culprit behind pathogenesis of tooth decay.[27]Similar to any other vaccine, caries vaccine should also be administered before the introduction of the infectious agent into the system. Hosts when immunized with S. mutans antigen, in response to it antibodies are formed within saliva which induce antigen-antibody reaction by cellular aggregation. These cellular aggregates minimizes the number of organisms adhering to the tooth surfaces.

Very few studies have analyzed the efficacy of active immunity against mutans streptococci in humans. Most of the authors verified the efficacy of oral administration. Mestecky et al. demonstrated that ingestion of capsules that contained Streptococcus sobrinus and this effectively induced sIgA in the saliva.[28] Contradicting to these findings, Gahnberg and Krasse when orally administered heat-killed S. sobrinus cells given to six subjects, resulting in no salivary IgA response.[29] Oral immunization in seven subjects with an enteric coated capsule containing 500 µg of GTF from S. mutans resulted in elevated salivary IgA antibodies to the antigen preparation. When similar antigen was administered intranasally or by topical application to tonsils, it resulted in increase of salivary IgA antibodies.[30,31]

Conclusion

"The preservation of what remains is of utmost importance than the meticulous replacement of that which has been lost."It is not possible to imitate natural tooth structure on a long term basis, so it is best that it should be retained as far as possible

To preserve healthy tooth structure, minimally invasive procedures and materials should be used because the carious process cannot be reversed. Newer treatment approaches allow us to preserve as much of the sound tooth structure as possible during caries removal. While further research is required, currently it can be concluded that Minimum Intervention has the potential to provide a more conservative approach to caries treatment as well as a health-oriented treatment choice. The ultimate aim of MID approach is to make a transition from "Extension for Prevention" to "Prevention of extension".

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An Original Research

To Determine the Sensitivity & Specificity of Quinacrine Dihydrochloride Stain For Gender Determination By F Body Present in Human Pulp Tissue

Munalisha Paul[1]
Malay Kumar[2]
Abhishek Khare[3]
Balasundari Shreedhar[4]
Mohd Adil[5]

Private Practitioner[1]
Dept of Oral & Maxillofacial Pathologist & Oral Microbiologist
Lucknow

Associate Professor[2]
Dept. of Oral pathology & Microbiology
Career PG Institute of Dental Sciences,
Lucknow

Professor& Head[3]
Dept. of Oral pathology & Microbiology
Career PG Institute of Dental Sciences,
Lucknow

Principal[4]
Career PG Institute of Dental Sciences,
Lucknow

Private Practitioner[5]
Dept. of Oral & Maxillofacial Pathologist & Oral Microbiologist
Lucknow

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Corresponding Author:

Munalisha Paul
Private Practitioner
Dept of Oral & Maxillofacial Pathologist & Oral Microbiologist
Lucknow

Abstract:

Y chromosome contains F-bodies. These F-bodies can be used to identify sex. The F-Body is typically described as a single fluorescent spot, approximately 0.25 um in diameter and of variable length, located halfway between the periphery and center of the nucleus. Y chromosome can be studied in the cells during interphase by staining with Quinacrine mustard when Y chromosome will fluoresce more brightly and its presence conclusively indicates the Y chromosome and sex in positive cases is invariably male.

Key Word: Quinacrine dihydrochloride,F body, pulp

Introduction:

Dental remains as teeth are an excellent material in living and nonliving populations for anthropological, genetic, odontologic and forensic investigations being hardest and chemically the most stable tissue in the body, they are selectively preserved and fossilized, thereby providing for the best records for evolutionary change. Their durability in the face of fire and bacterial decomposition makes them invaluable for identification.[1]

The present study uses the tooth pulp tissue from extracted human teeth as the substratum for sexual characterization. The first reason to select the pulp as the preferred tissue for this study is its sequestered location. Embedded in a chamber surrounded by intact highly mineralized dentin and enamel, the pulp is vulnerable to the external environment only at a small apical aperture.. Hence, the present study is designed to expand current knowledge on the constraints pertaining to sex discrimination in pulp tissue.

Source of data: The study sample consisted of 120 extracted teeth from patients (maxillary and mandibular combined) which were collected from the Department of Oral and Maxillofacial Surgery of Career Post Graduate Institute of Dental Sciences & Hospital Lucknow.

Methodology:

Sample For The F –body Test:

a) Of the 120 teeth taken for the study, 60were taken from male subjects (group a) and 60 were taken from female subjects(group b).
b) Pulp was obtained from groups a&b and each pulp smear were stained for F Body test by Quinacrine dihydrochloride (0.5%) dye.
c) Individual tooth sample were micro scopically examined from the groups in the present study.
d) Tooth were extracted by method described by KRUGER.

For F-body test: -

Sectioning of the teeth:

a) The tooth to be sectioned was embedded on modeling wax block
b) To free the pulp, the crown was separated longitudinally by using a carborundum disc at 30,000 rpm. Similarly the root was split for pulp removal
c) The whole of the pulp tissue was separated out of the pulp cavity, with the help of broach and forceps and transferred to a Eppendor f tube containing normal saline.
d) It was then adequately washed in normal saline to remove any debris.

Fig 1: Sectioned Tooth

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Obtaining clear suspension of pulp cells:

a) The pulp tissue was transferred to a dry and clear centrifuge tubes and 0.5 ml of fixative (20% acetic acid) was used to soften the dental pulp.
b) It was then crushed / teased with the glass rod sufficiently to isolate the pulp cells.
c) Again 2ml of fixative(20%acetic acid) was added and the suspension is stirred well.
d) A suspension thus obtained was centrifuged for 10 min at 1000 rpm.
e) The supernatant was discarded leaving behind the pellet in the centrifuge tube.
f) 2ml. of fresh fixative was then added to re-suspend the pellet and the process was repeated till a clear suspension of the pulp cell was obtained.

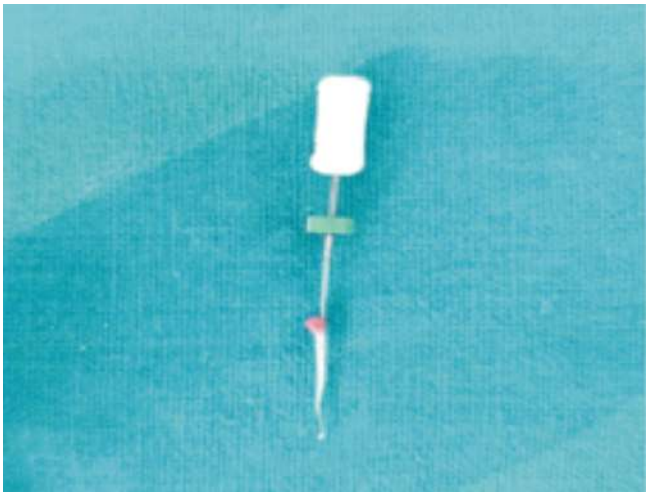

Fig: 2 Retrieved Pulp

Preparation of smear:

These smears were prepared on chilled glass slide by the air-drying method i.e., by dropping 2-3 drops of the clear suspension of the pulp cells on the slide from a distance of few inches, to obtain a monolayer of cells one smears was made from suspension of the specimen.

Fixing and Staining of the pulp smear staining with Quinacrine dihydrochloride:

a) After drying at room temperature, a few drops of methanol were added to fix the material.
b) After natural evaporation of methanol, the material was stained with 0.5% Quinacrine dihydrochloride for 20 minutes
c) The slide was then washed with double distilled water and kept in Mellvaine's buffer (0.1 M citric acid, 0.2M Bi basic sodium phosphate) with pH of 5.5 for 3 minutes.
d) The slide was then be washed with 0.4g/L magnesium chloride for 10 minutes and then a drop of Glycerol was added for mounting.
e) A cover slip was placed on the top, avoiding trapping of any air bubbles.

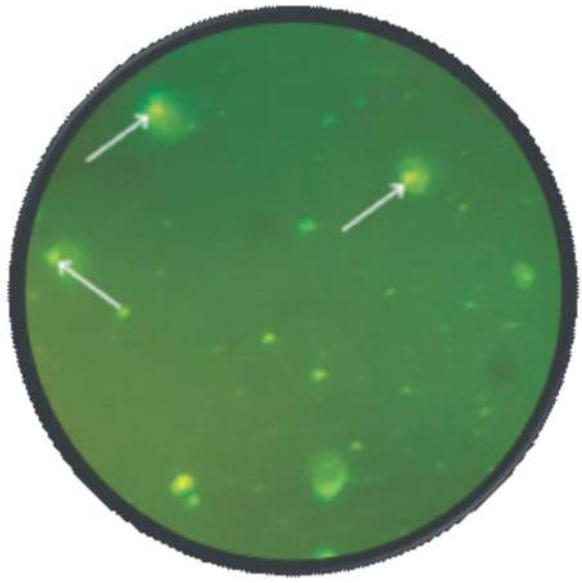

Fig: 3 Quinacrine Dihydrochloride Stained Cells [Positive For F Body] 40x

Specimen observation:

F Body were observed under high power lens (40x) of fluorescent microscope in dark field having blue glass as excitation filter and orange glass as barrier filter.
Only those cells which contained the characteristic Y chromatin i.e., a brightly fluorescent spot (F body) close to the nuclear membrane will be counted as positive.

Inclusion Criteria

- Subject who was active for prophylactic removable of asymptomatic tooth/teeth which would either Periodontally Compromised, Impacted, Indicated for extraction as a part of orthodontic treatment and subject with healthy mucosa.

Exclusion Criteria

- Subjects with any clinical sign/symptoms of any obvious pathology associated with the concerned tooth/ teeth and oral mucosa.

Result:

Corelation	Male	Female
Positive	46	1
Negative	14	59
Fisher's Exact Test P Value	<0.0001*	

*p-value significant

Table 1: Overall Gender Comparison of Q.S. for F-Body

Table 1 shows overall gender comparison of Q.S. for F-body. 46 males had positive and 14 males had negative Q.S. value for F-body, whereas 59 out of 60 females had negative values. Fisher's Exact Test P Value is <0.0001 showing p-value of less than 0.05. Thus, a statistically significant values positive Q.S. for F-body towards male and a negative correlation with female gender is seen.

		Gender Prediction	
Q.S. for F-body		**Male**	**Female**
	Positive	46	14
	Negative	1	59
Sensitivity (%)	97.87%		
Specificity (%)	80.82%		
Positive Predictive Value (%)	76.67%		
Negative Predictive Value (%)	98.33%		

Table 2: Sensitivity & specificity for Q.S. for F-body in gender prediction

Table 2 shows sensitivity of 97.87 %, specificity of 80.82%, Positive Predictive Value 76.67% and Negative Predictive Value 98.33% for Q.S. for F-body in gender prediction.

Discussion:

Y chromosome contains F-bodies. These F-bodies can be used to identify sex. Various studies have been under taken to identify F-bodies from pulpal tissue. Caspersson Tet al. (1970)[2]suggested that F-bodies can be applicable in forensic for sex determination. Dried blood stains, saliva, hair, and extracted dental pulp can serve as a sample for the test.

Bobrow and Vosa used quinacrine dihydrochloride (Atebrin) to demonstrate the Y chromosome in the interphase nuclei as a characteristic fluorescent body; thus, providing the ideal counterpart of the BB or X chromosome.[3]Pearson PL et al. (1970)[3]reported the fluorescent staining property of Y-chromatin in the nuclei of buccal mucosal cells, lymphocytes and fibroblasts and they found that the distal portion of the long arm of Y-chromosome fluoresced so intensely that it was easily recognized in both inter phase and mitotic nuclei as a distinctive fluorescent structure or F body Hence, the same material Quinacrine stain was used in our study to determine the F body.

Zech described a simple technique to demonstrate the Y chromosome using the quinacrine mustard.[4] The alkylating agent such as quinacrine, accumulate in DNA regions rich in guanine and is responsible for the bright fluore scence of the Y chromosome. Seno M et al. (1973)[5] carried out the detection of Y chromosome in the nuclei of dental pulp. They found that F body positive rate in the nucleated cells of male dental pulp was over 30%, even with the male teeth as old as 5 months, after the extraction. With female teeth, typical F body can not be detected, and F-body like spot has been observed in 0.4% of cells, indicating that there can be no error in the identification of male tooth from that of female one, even such an F body like spot is taken as an F-body itself.

In Table 1 the results showed that the overall gender comparison revealed a statistically significant values positive Q.S. for F-body towards male and a negative correlation with female gender. Fisher's extract test statistics showed p-value < 0.05.

Table 2 shows sensitivity of 97.87 % and specificity of 80.82% % for Q.S. for F-body in gender prediction.In the present study it was observed that there was sensitivity of 97.87 %, specificity of 80.82%, Positive Predictive Value 76.67% and Negative Predictive Value 98.33% for Q.S. for F-body in gender prediction with Fisher's exact test p value <0.0001 (significant) (Table 2).

In another study done by Khorate MM et al. (2014)[4] who determined the diagnostic performance of X (Barr body [BB]) and Y(F body [FB]) chromosomes observed in dental pulp tissue for gender determination of an individual. They showed that the percentage of FB was in the range of 0-8 with mean to be 2.56 ± 2.31. In males, the mean percentage of FB was found to be 59.8 ± 6.06 in the freshly extracted teeth_.

Conclusion:

F-body recognition, is an highly effective method as a means of sex determination by tooth pulpal tissue.

Quinacrine dihydrochloride is very satisfactory for qualitative study, involving the differentiation of chromosomes and the visualization of Y chromatin.

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A Review

Implications of Finite Element Analysis in Orthodontics.

Dr. Subhi Aliya[1]
Dr. Ashish Garg[2]
Dr. Amit Tripathi[3]
Dr. Kamalshikha Baheti[4]
Dr. Shabdika Baghel[5]
Dr. Agraj Sharma[6]

Postgraduate Student[1]
Department of Orthodontics & Dentofacial Orthopaedics,
Sri Aurobindo College of Dentistry,
Indore (M.P.), 453555, India.

B.D.S. , M.D.S[2]
F.P.F.A, F.I.C.D (U.S.A)
Certified Cleft & Craniofacial Orthodontist.
(Smile Train – U.S.A)
Diplomate of Indian Board of Orthodontics (D.I.B.O.)
Professor and Head,
Department of Orthodontics & Dentofacial Orthopaedics,
Sri Aurobindo College of Dentistry,
Indore (M.P.), 453555, India.

B.D.S. , M.D.S[3]
Reader,
Department of Orthodontics & Dentofacial Orthopaedics,
Sri Aurobindo College of Dentistry,
Indore (M.P.), 453555, India.

B.D.S. , M.D.S[4]
Professor,
Department of Orthodontics & Dentofacial Orthopaedics,
Sri Aurobindo College of Dentistry,
Indore (M.P.), 453555, India.

B.D.S. , M.D.S[5]
Senior Lecturer,
Department of Orthodontics & Dentofacial Orthopaedics,
Sri Aurobindo College of Dentistry,
Indore (M.P.), 453555, India.

B.D.S. , M.D.S[6]
Senior Lecturer,
Department of Orthodontics & Dentofacial Orthopaedics,
Sri Aurobindo College of Dentistry,
Indore (M.P.), 453555, India.

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Quick Response Code:

Corresponding Author:

Subhi Aliya
Postgraduate Student[4]
Dept. of Orthodontics & Dentofacial Orthopaedics
Sri Aurobindo College of Dentistry,
Indore (M.P.), 453555, India

Abstract-

Background- Orthodontics, a branch of dentistry focused on realigning teeth, has benefited from the application of Finite Element Analysis (FEA). FEA is a computational method that calculates stress and displacement within structures under specific loads. In orthodontics, FEA has been used to analyze the biomechanical effects of treatment methods and understand bone remodeling. This article provides an overview of FEA in orthodontics, discussing its fundamentals and outlining the steps involved in the process. FEA allows for accurate quantification of stress and strain patterns in the periodontal ligament, bone, and tooth structures, contributing to improved understanding and precision in orthodontic treatment. Computed Tomography (CT) scans are used to generate FEA models, and morphological analysis provides insights into the characteristics of dental structures. FEA is also used to study bone remodeling and dentofacial orthopaedics. However, FEA has limitations, including the need for careful modeling and the cost involved. Overall, FEA has proven to be a valuable tool in orthodontics, enhancing treatment planning and providing insights into the biomechanics of tooth movement and bone remodeling. Conclusion- Finite Element Analysis (FEA) is a powerful tool in orthodontics that allows for the accurate quantification of stress and strain patterns in the teeth, periodontal ligament, and bone structures during orthodontic tooth movement. It provides valuable insights into the structural behavior of teeth and helps improve treatment planning and outcomes. While FEA has its limitations and should be complemented by clinical trials, its application in orthodontics holds great promise for advancing evidence-based practices and customized treatment approaches.

Keywords- Finite Element Analysis, Geometric model construction, Dentofacial orthopaedics.

Introduction-

Orthodontics is a branch of dentistry that uses force delivery systems to realign teeth. It has connections to engineering and physics principles, as forces and their consequences play a crucial role in orthodontic treatment. The objectives of orthodontics include improving function, aesthetics, and oral hygiene. [(1)] Finite Element Analysis (FEA) is a computational method initially proposed in 1956 that has been widely used in various fields, including engineering. FEA calculates stress and displacement within a structure under specific loads. In orthodontics, FEA has been employed as a powerful tool to analyze the biomechanical effects of different treatment methods and understand the complex bone response to external stresses. By assessing stress, strain, and displacement in living tissues, FEA helps comprehend bone remodeling and in regards to the treatment outcomes.[(2)] The article discusses the fundamentals of FEA and how it is used in orthodontics, outlining each stage of the process.

Utility of Fem-

Orthodontics is shifting towards evidence-based practices backed by scientific research.[(3)] Finite Element Analysis (FEA) is a valuable tool used in orthodontics to study the structural behavior of teeth, considering factors such as material characteristics and geometry.[(4)] FEA allows for accurate quantification of stress and strain patterns in the periodontal ligament, bone, and tooth structures during orthodontic tooth movement. Additionally, it can simulate the stresses acting on a single tooth, account for variations in root length, and describe how the periodontal ligament varies with age. [(5)] These advancements in research and FEA contribute to the improved understanding and precision of orthodontic treatment.

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Road to FEM-

The Finite Element Method (FEM) involves dividing a complex structure into smaller components or elements based on physical characteristics. This approach, known as finite element analysis, allows for the study of how the structure responds to external stimuli, including orthodontic forces. The FEM utilizes nodal points as building blocks, forming a meshwork that simplifies the structure.[6] This method offers control over the level of simplification, providing advantages over other approaches.[7] Pre-surgical planning may be done using FEM, and it has the potential to take the role of stereolithographic models. Each element in FEM is defined by an assumed shape function that expresses internal displacement as a function of nodal displacement. This means that an element may provide an accurate response for a specific support and loading scenario but could yield an incorrect response for different conditions.[8]

Steps in FEM-

1. The geometric model construction.
2. The geometric model to a Finite element analysis model conversion .
3. Data representation of the material properties .
4. The boundary condition defining .
5. Application of the load .
6. Solution to the linear algebraic equation system.
7. Analyzing the results. [8]

Basic Steps in Finite Element Method:-

The Geometric Model Construction-

To analyze a geometrical model, it can be created in a CAD program and imported into analysis software, or computed tomography images can be used as a geometrical model. The model must meet specific conditions and be saved with the appropriate file extensions.

Discretization Process-

Discretization is a method that breaks down the domain or component into smaller elements connected by nodes. By examining the stress distribution inside each piece and integrating them to create an overall stress distribution, this approach increases accuracy. This process allows for a precise visualization of the component's stress distribution.

Applying Material Properties-

In this stage, the mechanical properties of the component, such as Young's modulus and Poisson's ratio, are determined and assigned to the model. These properties are essential for calculating the response of the component to stress. The operator specifies the type of element to be used and assigns the appropriate properties.

Defining Boundary Conditions & Nature of Problem-

The boundary condition is chosen depending upon the mode of analysis such as structural, dynamic, thermal, fluid etc.

Application of Load-

Boundary constraints are applied to the discretinized domain, and known loads are applied to the nodes based on the geometry of the component. Different types of loads, such as pressure, gravity, forces, or moments, are used depending on the analysis requirements, such as structural or thermal issues.

Results-

The results can be obtained quickly and accurately through model images representing different stress levels using color-coded representations. A color chart is provided for interpretation. The results can be compiled and sent for further analysis.

Computed Tomography (CT) & Extraction of Morphological Parameters From CT Scans -

Computed tomography (CT) is an imaging technique that creates cross-sectional images of objects by capturing transmission or reflection data from multiple angles. It involves exposing a sample to radiation and measuring the amount of radiation transmitted or reflected. The resulting projections represent the attenuation of X-rays or other radiation within the object. These projections can be reconstructed to create 2D maps of the attenuation coefficient distribution, which can be stacked to form a 3D image. Hounsfield Units (HU) are used to quantify attenuation coefficients. CT is used to create a 3D model of bone microstructure, which can be further analyzed using morphological examination.[9] fig 1

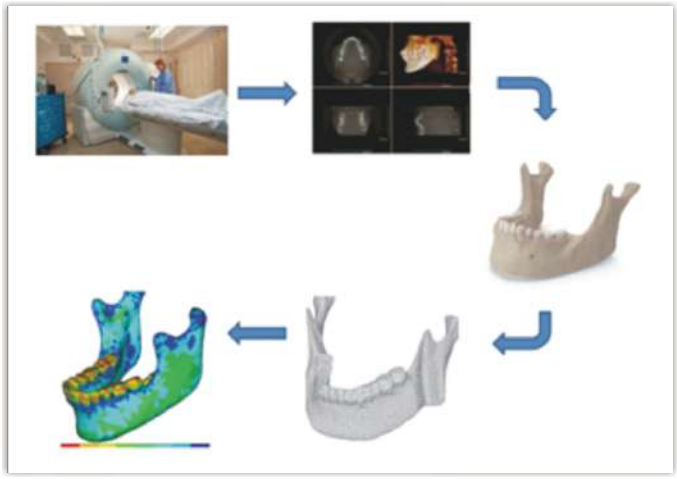

Fig. 1- Conversion of CT scan into Finite element model.

Generation of FEM Model-

The geometry of the tooth and periodontal tissues, the properties of the materials, and the distribution of loads are the major aspects to take into account while building a three-dimensional finite element tooth model. Nodes represent points at the corners of elements that define the tooth and periodontium structure, and boundary conditions are assigned to these nodes. Each component is assigned specific material properties. Creating a 3D model requires accurate geometric input, typically obtained through CT scans. The model is meshed, and material attributes are assigned to each component. [9] fig. 2

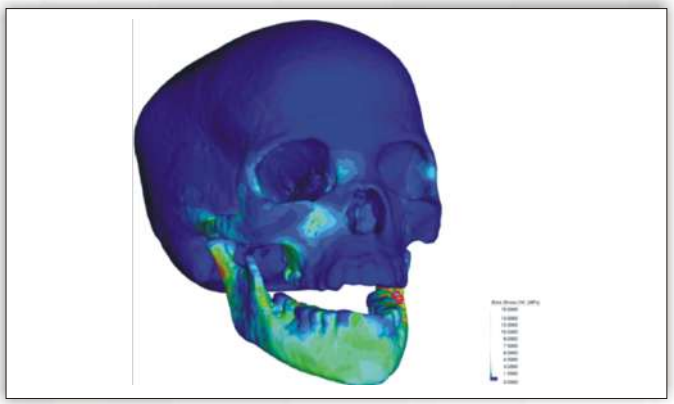

Fig. 2 FEM model of skull

Morphological Analysis-

Morphological analysis involves extracting morphological parameters from an object. The parameters include tissue volume (TV), bone volume (BV), trabecular thickness (Tb.Th), and the ratio of BV to TV. TV quantifies the volume of the overall region of interest, while BV represents the volume of the solid phase. Tb. Th refers to the thickness of the trabecular rods, and BV/TV is the ratio of bone volume to tissue volume. These parameters provide insights into the morphological characteristics of the object.[10]

Distribution of Trabecular Thickness-

Trabecular thickness (Tb.Th) is determined by finding the largest sphere that fits within a point inside the body, considering the distribution and thickness of trabeculae. This calculation involves constructing the object's body and considering the trabecular midline.[11,12]

Fundamentals in non linear computation method - Biomechanics, a field rooted in mechanics, focuses on the application of forces and how living organisms respond to them. It is important to understand mechanics in order to grasp the principles of biomechanics. This interdisciplinary field encompasses various levels of organization, from subatomic particles to the organized structures of living bodies, and utilizes different branches of mechanics to study phenomena at different scales. [13]

Finite strains associated with a body in its kinetics - Continuum mechanics theory states that the volume of a body at a given time is denoted as V(t), and the surface area is represented by S(t). A change in dimension occurs when the body is put under stress. It is crucial to have a solid understanding of kinematics to comprehend the transition in shape of the body before and after applying stress.[14]

Biomechnaics of Bone Remodelling in Orthodontics Models-

Mathematical models, including analytical and numerical finite element models, play a significant role in dentistry for research and treatment planning. These models focus on tooth movement and the constitutive models applied to dental tissues. However, implant-related issues are not considered in the current discussion. The models primarily examine the forces applied, while the mechanisms of force delivery, such as brackets, are not taken into account[15]

Gingiva- The gingival tissue surrounding the dental arch acts as additional support for the teeth and tends to contract, causing asymmetrical behavior during tooth rotation. The presence of collagen in the gingiva gives it a viscous quality. However, the mechanical activity of the gingiva is often overlooked in finite element investigations of tooth movement. [16]

Dental components- Enamel is a hard and brittle substance composed mainly of inorganic components. Cementum has limited research but has been studied for its physical properties. Dentin is strengthened by tubules and exhibits viscoelastic properties. Dental pulp is poorly characterized. The periodontal ligament (PDL) is a connective tissue that secures teeth to the bone, showcases as a shock absorber, and transfers forces during chewing. The PDL is considered bilinear elastic or non-linear, depending on the study. Various models, including elastic, viscoelastic, and poroelastic, have been used to simulate PDL behavior. [17,18] fig 3

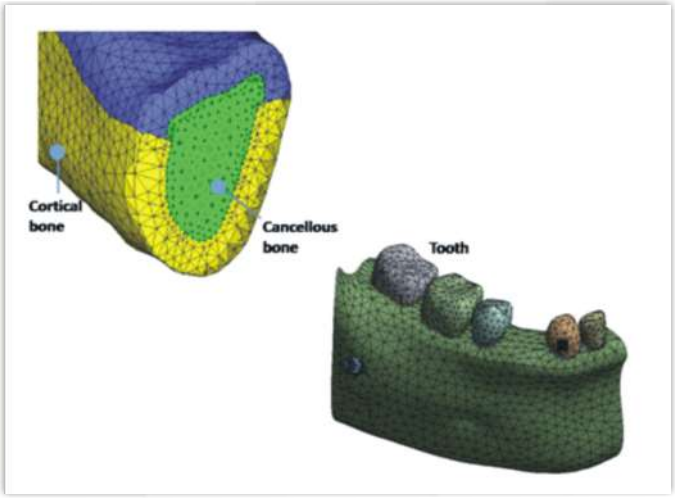

Fig. 3 Mesh Model after assigning material properties for Dento-Alveolar complex.

Orthodontic Tooth Movement Model-

A. Initial tooth movement- The finite element method (FEM) has been utilized in orthopaedic biomechanics and orthodontics since the 1970s. It is commonly used to analyze stress patterns, improve appliance design, and study material properties and bone responses in dentistry. Biomechanics is integrated into orthodontics, with a focus on the non-linear behavior of the periodontal ligament. Early orthodontic models examined tooth movements following the application of forces, while recent research incorporates more complex force systems and geometrical constraints. Models consider factors like non-uniform bone density, anisotropic nature of the periodontal ligament, and orthotropic behavior of the bone. [19,20]

B. Long term tooth movement- The pressure tension hypothesis states that initial tooth movement is driven by the periodontal ligament (PDL) fibers. The tooth then becomes robust in its new location. Finite element analysis (FEA) models may incorporate bone remodeling laws to update displacement or forces based on stimuli like strain energy density or stress energy density.These models follow equilibrium principles to analyze forces and tooth movement from start to finish. [21]

Dentofacial Orthopaedics Modelling-

Finite element models of the mandible and maxilla have been used in orthodontics since the 1980s. These models represent the structure of bone and its properties using analogous components. Factors such as the magnitude of forces applied by orthodontic equipment and the temporomandibular joint (TMJ) movement are considered in the model. The materials used to simulate bones are typically linear elastic, distinguishing cortical bone from trabecular bone. The depiction of teeth varies among craniofacial models. TMJ models may incorporate linear elastic or hyperelastic materials to depict cartilage and discs. Muscle activation can be incorporated through inverse dynamic analysis or by modeling specific muscles using spring models. These models can also predict how the face bones and skull would react when confronted with external orthopaedic devices.[22]

Bone Remodelling Models-

Bone remodeling is a self-organized process involving the actions of osteoblasts and osteoclasts, which contribute to bone stability and growth. An orthodontist must have a brief knowledge of bone remodeling process to predict tooth movement. The "Roux hypothesis:" states that bone becomes stiff, stress is generated, and the bone structure complies with "Wolff's law" in response to applied forces. The "Frost model", known as the mechanostat theory, explains that bone formation occurs when stress exceeds a certain threshold, while bone loss can occur if stress is below the optimal level. Both models work together to maintain equilibrium. Mathematical equations are used to computationally model bone behavior, considering factors like poroelasticity and remodeling depth.[23]

FEM in Orthodontic Tooth Movement –

Finite Element Analysis (FEA) is a theoretical study concept that should be complemented by clinical trials in orthodontics. FEA considers material properties, geometry, and initial forces to predict the final tooth position accurately. It plays a crucial role in understanding the stress-strain relationships across the tooth, periodontal ligament (PDL), and alveolar bone. The PDL's viscous nature and energy storage contribute to bone remodeling. Different types of forces, such as longitudinal, compressive, and shear, can act on teeth in various orientations. The stress distribution along the crest of the alveolar bone varies depending on the forces applied, with the highest stress occurring near the apex and cervical level. The accuracy of FEA results depends on the model, material properties, and boundary conditions used. Friction in orthodontic systems can significantly affect the tension created in the PDL. Clinical trials and further considerations are necessary to fully understand and utilize the implications of FEA in orthodontics.[24]

Limitations of FEM -

The use of theoretical models in biological systems, such as Finite Element Analysis (FEA), comes with limitations that must be considered. Inaccurate outcomes may occur from modelling errors, especially those involving material characteristics and boundary conditions. The complexity and dependence on computer programs require careful consideration during the modeling phase. Replicating live biological material in mechanical models is challenging.[25] Additionally, the cost of FEA research is a major limitation, making it impractical to use for every patient in dentistry or orthodontics.

Conclusion-

The movement of teeth within the jaw bones, a challenging and drawn-out procedure, is the major focus of orthodontics. Predicting the final tooth position accurately can save time and minimize patient discomfort. The link between the mechanical and biological reactions of the alveolar bone and periodontal ligament (PDL) to orthodontic forces can be better understood with the use of biomechanical models like the Finite Element Method (FEM). FEM is a precise engineering method with prospective uses in biomedical research, dentistry, and orthodontics. However, it is important to recognize that each individual is unique, and no single FEM study can accurately predict outcomes for all patients. Customized FEM research based on individual characteristics is necessary for more accurate predictions.

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A Review

Orthodontic Bone Screws: A Comprehensive Review

Sania Khan[1]
Rakesh Thukral[2]
Ashish Garg[3]
Kamalshikha Baheti[4]
Amit Tripathi[5]
Amit Singh Choudhary[6]

Postgraduate Student[1]
Department Of Orthodontics & Dentofacial Orthopaedics
Sri Aurobindo College of Dentistry,
Indore (M.P.), 453555, India

B.D.S., M.D.S[2]
Professor,
Department of Orthodontics & Dentofacial Orthopaedics
Sri Aurobindo College of Dentistry,
Indore (M.P.), 453555, India

B.D.S., M.D.S[3]
F.P.F.A, F.I.C.D (U.S.A)
Certified Cleft & Craniofacial Orthodontist
(Smile Train – U.S.A)
Diplomate of Indian Board of Orthodontics (D.I.B.O.)
Professor and Head,
Department of Orthodontics & Dentofacial Orthopaedics
Sri Aurobindo College of Dentistry,
Indore (M.P.), 453555, India

B.D.S., M.D.S [4]
Professor,
Department of Orthodontics & Dentofacial Orthopaedics
Sri Aurobindo College of Dentistry,
Indore (M.P.), 453555, India

B.D.S., M.D.S[5]
Reader,
Department of Orthodontics & Dentofacial Orthopaedics
Sri Aurobindo College of Dentistry,
Indore (M.P.), 453555, India

B.D.S., M.D.S[6]
Senior Lecturer,
Department of Orthodontics & Dentofacial Orthopaedics
Sri Aurobindo College of Dentistry,
Indore (M.P.), 453555, India

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Quick Response Code:

Corresponding Author:

Dr. Sania Khan
Postgraduate Student
Department of Orthodontics &
Dentofacial Orthopaedics
Sri Aurobindo College of Dentistry,
Indore (M.P.), 453555, India

Abstract

In orthodontics, anchorage plays a crucial role in facilitating accomplishment of desired objectives with minimal inadvertent side effects. One of undesirable effects is loss of anchorage. However, introduction of Temporary Anchorage Devices (TADS) has brought about significant advancements in the field of orthodontics. In recent years, Orthodontic Bone Screws (OBS) which are placed into Infra-zygomatic crest of maxilla & Buccal Shelf area of mandible offer an extra-radicular placement modality without requirement for extensive surgical interventions. Notably, OBS have demonstrated significantly reduced failure rates compared to conventional mini-implants. Consequently, OBS have revolutionized orthodontic treatment approaches by providing enhanced stability and efficiency in anchorage, thereby leading to optimal treatment outcomes.
This comprehensive review provides an in-depth analysis of the evolutionary progression of orthodontic anchorage systems, with particular emphasis on the transformative impact of Orthodontic Bone Screws. By virtue of their distinctive placement techniques and enhanced stability attributes, Orthodontic Bone Screws have catalyzed remarkable advancements in the field of orthodontics, ultimately leading to the attainment of superior treatment outcomes.

Keywords: Biomechanics of bone screws, biomechanics of micro-implants, BSS, Buccal Shelf area, full arch distalization, Infra-zygomatic crest, IZC, mini-implants, orthodontic bone screws.

Introduction:

Orthodontic treatment relies on achieving stable anchorage to minimize undesired tooth movements and optimize treatment outcomes.[(1)] Traditional methods have faced challenges in maintaining anchorage, necessitating advance-ments in skeletal anchorage systems. In recent decades, absolute anchorage systems, such as mini-implants or micro-screws, have gained popularity due to their ease of placement and minimally invasive nature. However, early loosening remains a common drawback. Skeletal Anchorage Systems (SAS), like I-plates and Y-plates, offer a more rigid alternative but require extensive surgical intervention.[(2)]

In recent years, the development of Infra-zygomatic crest (IZC) & Buccal Shelf (BS) screws has aimed to overcome limitations in traditional mini-screws. These screws, positioned intraorally into basilar bone by penetrating oral mucosa, offer strong osseous anchorage. Lever arm springs anchored with IZC or MBS bone screws effectively manage impaction recovery, while their Extra-alveolar placement facilitates dentition retraction and arch rotation.[(3)]

Segmented & full arch distalization using extra-radicular bone screws have revolution-ized orthodontics. These techniques offer non-extraction options and effectively address cases with anchorage loss during retreatment. As orthodontic retreatment is increasingly common due to poor mechanics, finding alternative means to rehabilitate clinical situations is imperative. Implemen-tation of Infra-zygomatic crest (IZC) & Buccal Shelf screws (BSS) provides hope while reducing re-treatment time. However, careful usage is crucial, considering anatomical limitations, artistic skills, biomechanical perspectives, and potential side effects. This technique requires a comprehensive understanding of these factors for optimal treatment outcomes.[(2)]

A Brief Review of Literature:

Edward H. Angle [(4)] introduced the idea of stationary anchorage leading to enhancement of Extra-oral anchorage systems. Gainsforth et al. (1945)[(5)] began the era of skeletal anchorage. Leonard Linkow (1969)[(6)] used endosseous implants for using Class II elastics for retraction of maxillary incisors. Branemark (1970s)[(7)]noticed efficacious osseo integration of implants into bone, after that numerous

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Orthodontists amplified their curiosity in implants for Orthodontic anchorage. Creekmore et al. (1983)[8] implanted vitallium surgical bone screws beneath spina nasalis for anchoring upper incisor intrusion.

Erick J.W. Liou et al. (2007)[9] measured the Infra-zygomatic crest thickness to guide the safe insertion of miniscrews without damaging the maxillary first molar root. Eric Liou (2017)[10] recommended using the Infra-zygomatic crest for temporary anchorage devices, particularly above the mesiobuccal or distobuccal roots of the second molar (U7). The Ortho Bone Screw (OBS) by OrthoBoneScrew®, developed by Dr. Eric Liou, is commonly used for these procedures. HaiboLiu et al. (2019) [11] used CBCT to assess the mandibular buccal shelf (MBS) anatomy and determine the optimal region for miniscrew implantation for mandibular dentition distalization. They found that the L6db-L7mb region (distobuccal root of first molar and mesiobuccal root of second molar) is preferred choice for miniscrew insertion in the Buccal Shelf region for mandibular dental segment retraction.

Design of Orthodontic Bone Screws:

Elements of Implant Design:

1. Choice of material
2. Design of the head portion
3. Dimensions of Bone screw

1. Choice of material:

Fracture resistance is especially important for Bone screws since they are often implanted in DI (>1250 HU) grade bone (IZC & BS regions).[2] Stainless steel's superior **resistance to fracture** makes it the material of choice over Ti alloy.

2. Design of the head portion:

Mushroom shape design of head portion is the most common.[2] **(Figure. 1)**

Figure 1. Design of head portion of Bone screws.

3. Dimensions of Bone Screw:

The Bone screws used in Orthodontics typically have diameter of 2mm & are obtainable in lengths of 10mm, 12mm, & 14mm. For optimal stability, a minimum bone length of 8 mm is required. **(Table 1)**

Table 1. Dimensions of Orthodontic Bone screws:

S. No.	Location (Extra- alveolar)	Screw	Screw Diameter (mm)	Screw Length (mm)
1	Maxilla (Thick soft tissue)	IZC	2	14
2	Maxilla (Thin soft tissue)	IZC	2	12
3	Mandible	BSS	2	10

Placement of Bone screws:

Implants with larger diameters and longer lengths can withstand a higher fracture torque making them resistant to torsional fracture and are preferable for Extra alveolar (E-A) locations. [12]When these implants are to be put in a region of dense bone (cortical bone), it may be necessary to perform a first puncture using spear-tip or clinical probe. This is evident even while utilizing self-drilling orthodontic steel implants. Reducing potential for fracture during implantation is the primary goal of this treatment.[13] According to research by Motoyoshi et al., drilling a pilot hole, in cortical bone prior to implant insertion may improve main stability of mini-implants into adolescents.[14]

Placement of Infrazygomatic Crest Screw:

When inserting a bone screw into the IZC, the angle of insertion is crucial. Park et al.[15] correlated angle between mini-implant's axis & cortical bone, and they found that when axis is virtually parallel to long root axis of molars, implant has a larger contact area with the bone. When the screw is positioned vertically, it has less of a likelihood of reaching root. For placement of Infrazygomatic crest screw:

1. The surgical area is anesthetized.
2. Self-drilling screw point is positioned at 90° angle to bone surface into area of Infra-zygomatic crest (IZC).
3. Screws are often placed between upper first & second molars in adults & upper second premolar & first molar in young patients, with point of screw penetrating 1mm in cortical bone at height of buccal roots.
4. Bone screw driver is turned clockwise while rotating it between 60°-70° towards the occlusal plane, effectively threading the bone screw into the bone.

Placement of Buccal Shelf Screw:

Nucera et al.[16]& Elshebiny et al.[17]described optimal anato - mic position for placement is 4–8mm distal to cement-enamel junction upon buccal aspect of root of lower second molar.

Significant morphological variation exists in this area, with some patients having well-demarcated bone plateaus while others have straighter profiles. Diagnosis through palpation or CBCT helps identify these differences and guides appropriate implant placement. Placement of the implant is simplified for individuals who have a distinct plateau and healthy, attached gingiva; a sizable Buccal Shelf (BS) enables the implants to be placed into virtually vertical position, practically parallel to root of lower molars.

Technique for implantation is similar to that used for IZC implants; i.e., after abiding biosafety guidelines, local anesthetic is administered, & cortical bone is drilled. The implant is then positioned at ideal angle (70 degrees) with respect to occlusal plane. Based upon biomechanics, implants may be angled mesially in certain cases.[13]

A single bone screw can handle up to 300-350 g of force, allowing for immediate loading.[2]

Biomechanics of Bone screws:

a. Infrazygomatic crest Screw

Incisor torque control might be impacted with alterations in force geometry, such as those instigated by change in hooks or power arm located into anterior region of arch, and also by variations in vertical heights (open or deep bite).[18] In addition, the potential inclination of occlusal plane must be taken into account when using asymmetrical forces to rectify Class II subdivision using mini-implants in IZC. Attention should be paid to precise application of the forces' path of action in the case of asymmetrical treatments of midline abnormalities. The intended kind of motion will be determined by the height and placement of anterior hook/power arm. Clinically, such differential motions may be re-produced upon anterior teeth using mechanics utilising extra-alveolar mini-implants by adjusting force line of action, via variations in length of hooks/power arms. Park et al[19] emphasized the need for archwires with long hooks to be employed throughout full maxillary dentition retraction for generating lingual root torque for incisors.

b. Buccal Shelf Screw

Entire mandibular dentition can be retracted at once with this mechanism because the screws are placed outside roots' line of action and do not hinder the retraction of entire arch (with exception of third molars, which must be extracted).

Roberts et al[20] analysed using finite elements (3D) and cone beam computed tomography (CBCT) showed existence of stable, "statically determinate" system resulting from mechanics for retracting the entire mandibular dentition; this was accomplished by placing 2 mini-implants in the Buccal Shelf (BS) & full-size rectangular archwire, with NiTi springs applying a constant force of 200g. As retraction force in whole arch produces an intrusive force in molars & extruding force in incisors due to rotation of mandibular arch, this system is an excellent resource for a conservative & non-extraction treatment of Class-III malocclusion with anterior open bite. Open bite closure & simultaneous Class-III correction were favored by this counterclockwise rotation of mandibular plane, as measured by finite elements analysis, which caused 3-mm molar intrusion & 2-mm incisor extrusion.

Clinical applications of Bone Screws:

1. Camouflaging a Class II & Class III malocclusion by distalization of the maxillary and mandibular dentition,
2. Re-treatment cases involving loss of anchorage often require the distalization of dental arches, which can be challenging using conventional orthodontic mechanics.[2]
3. In adjunct with Clear aligners:
   Clear aligners have revolutionized orthodontic treatment for various malocclusions.[21] Bone screws provide reliable anchorage for managing challenging malocclusions, such as scissors-bite discrepancies and full buccal cross-bites.
4. Molar uprighting.
5. Recovery of impacted teeth.
6. Segmental distalization.
7. Single-tooth intrusion into full-arch tooth arch.

Contraindications:

1. Pan systemic conditions
2. Psychological disorders.
3. Periodontal infections.
4. Neoplastic lesions.
5. Poor bone quality or inadequate space.
6. Oral mucosal disorders.

Risks & Complications:

Most unfavorable effects of clinical usage of bone screw anchorageis screw breakage that may happen either during installation or removal. There are a number of possible causes of screw failure, but close proximity of screw and root is the most prevalent. Damage to soft tissues heals quickly, while damage to hard tissues cannot be repaired and must be avoided at all costs. Bone screw anchoring comes with its own set of hazards and difficulties, so it's important to be aware of them and exercise caution while applying them.[22]

Advantages of Bone Screws:

OBSs, placed in IZC & BS regions, provide secure anchorage with stable bone and high density. Made of stainless steel, these screws offer excellent biocompatibility, mechanical characteristics, corrosion & stress resistivity.[23] Their unique features, including a mushroom-shaped head and double-neck design, enhance patient comfort, elastic chain retention, hygiene control, and allow for additional attachments.[24] The use of OBSs results in shorter treatment time, reliable anchorage, and reduced reliance on patient cooperation. They effectively correct crowding by retracting buccal segments and increasing arch length without the need for tooth extraction.

Conclusion:

In conclusion, orthodontic bone screws (OBSs) have emerged as a valuable tool in modern orthodontic treatment. Their placement in infra-zygomatic crest (IZC) &buccal shelf (BS) regions offers stable anchorage with favorable bone quality and density.

While OBSs present advantages such as enhanced treatment efficiency, less patient cooperation, and precise control over tooth movement, it is crucial to be aware of the associated risks, such as screw fracture and soft tissue irritation. Proper placement techniques, pre-drilling, and attention to hygiene control are essential to minimize complications and ensure successful outcomes. Despite the documented benefits of OBSs, their incorporation into routine clinical practice has been relatively limited. Raising awareness and increasing comfort levels among orthodontists regarding OBS utilization may lead to broader adoption and improved treatment outcomes for challenging cases.

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A Review

An Insight To Clear Aligners

AshishGarg[1], Sandhya Jain[2], Puneet Batra [3] Disha Ramrakhyani [4] , Amit Singh Choudhary [5], Agraj Sharma[6]

B.D.S. , M.D.S[1]
F.P.F.A, F.I.C.D (U.S.A)
Certified Cleft & Craniofacial Orthodontist
(Smile Train – U.S.A).
Diplomate of Indian Board of Orthodontics (D.I.B.O).
Professor and Head,
Department of Orthodontics & Dentofacial Orthopaedics.
Sri Aurobindo College of Dentistry,
Indore (M.P.), 453555, India .

B.D.S. ,MDS (KGMU), FPFA, MPTA, MWFO, FICD.[2]
Professor & Head
Department of Orthodontics & Dentofacial Orthopaedics
Sri Aurobindo College of Dentistry,
Indore (M.P.), 453555, India

BDS, MDS (AIIMS)[3]
MOrth RCS (Edinburgh), FFD Orth RCS(Ireland),
FDS RCPS (Glasgow), FDS RCPS (Glasgow),
FDS RCS (Eng), FDS RCS (Edinburgh)DNB,
DIBO, PGDHM, PGDMLS, PGCOI, MNAMS

Postgraduate Student[4]
Department Of Orthodontics & Dentofacial Orthopaedics
Sri Aurobindo College of Dentistry,
Indore (M.P.), 453555, India

B.D.S. , M.D.S[5]
Senior Lecturer,
Department of Orthodontics and Dentofacial Orthopaedics
Sri Aurobindo College of Dentistry,
Indore (M.P.), 453555, India

B.D.S. , M.D.S[6]
Senior Lecturer,
Department of Orthodontics and Dentofacial Orthopaedics
Sri Aurobindo College of Dentistry,
Indore (M.P.), 453555, India

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Corresponding Author:

Disha Ramrakhyani
Postgraduate Student[4]
Dept. of Orthodontics & Dentofacial Orthopaedics
Sri Aurobindo College of Dentistry,
Indore (M.P.), 453555, India

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Abstract :

Several major developments have changed the field of orthodontics in the recent years. Digital imaging and computers have improved the diagnostic process. The introduction of prescription brackets, bonding, NiTi and other alloy wires have improved the treatment efficiency and efficacy. The paradigm shift in orthodontics arrived with the introduction of Aligner System. It allows both dental practitioner and patient to develop a visual understanding of orthodontic tooth movement. The esthetic and practical advantages of the system have extended orthodontic services to a greater population. This current review is to highlight the knowledge and application of clear aligners in not just simple but complicated malocclusion too, which is only possible with theoretical knowledge.

Keywords- Clear Aligner

Introduction

Adult patients seeking orthodontic treatment are increasingly motivated by aesthetic considerations. The majority of these patients reject wearing labial fixed steel appliances and are looking instead to more aesthetic treatment options, including ceramic brackets, lingual orthodontics and clear plastic appliances[2].

The two contemporary systems for moving the teeth with plastic appliances are the **Aligner & Essix System[3].** The Aligner involves a series of aligners made from a transparent, thin (typically less than 1 mm) plastic material formed with CAD-CAM laboratory techniques. These aligners are similar to the splints that cover the clinical crowns and the marginal gingiva.

Each aligner is designed to move the teeth a maximum of about 0.25 to0.3mm over a 2-week period, and is worn in a specific sequence. The Aligner System is unique in that the clinician must be able to plan the path to optimum results before treatment is initiated sot hat series of aligners can be constructed toachieve the treatment goals[3]. However, the Es six system is based on adjusting one single appliance to achieve the treatment goals[3]. Conventional fixed appliances are constantly undergoing in evolution because of use of multiple and different types of variables that arise during treatment; so is it with Es six technology. Tooth movement is possible in all planes of space and the fabrication expense is a fraction of the cost of multiple laboratory fabricated appliances that must be used sequentially. Because Es six plastic appliances can be fabricated in the office, the cost of fabrication is minimal.

Clear plastic tooth moving appliances are excellent options for adults or responsible adolescents who might be reluctant to wear the fixed appliances and who will follow clinicians directions, and whose chief complaint centres around mild to moderate alignment problems. This discipline requires the essential elements of orthodontic tooth movement-force, space and time. The clinician can control two of these essential pre requisites– force and space. As with any dynamic removable appliance, the patient must provide the third essential – time. Therefore, the target population that is most eligible for tooth movement with plastic appliances are adults[2]. Adole scents are usually not included in the plastic alignment population because strict adherence to clinical instructions is not predictable in that age group. Some clinicians believes that children and adolescents are best treated with conventional fixed appliance.

Discussion

The Aligner System influences visualization of treatment and timing of aligner and fixed appliances. Soft wears should be seen as a supplemental part of diagnosis and treatment planning and can help to clarify the relationship between vertical,transverse, and anteroposterior movements. It offers the orthodontist a new way of viewing treatment goals. Skeletal changes that can be performed easily in all soft wears are antero posterior corrections of the maxillary and mandibular Jaws..[5-10]

Clear aligner

In early 20th century. numerous advances in field of dentistry that have made a revolutionary changes in appliances and materials which led to change of perception amongst adult patient seeking orthodontic treatment with esthetic consideration ,which has led to .

The theory of using an aligner to straighten teeth was first postulated in the1940s when Kesling produced a tooth positioning appliance to refine the final stages of orthodontic treatment (Kesling, 1946)[2]. This positioner was a piece of pliable rubber manufactured from a laboratory wax up of the teeth in a class I occlusion (Phan and Ling, 2007). This appliance allowed for minor tooth movements to be achieved while maintaining alignment of the remaining teeth in the arch. Tooth control was difficult, and only tipping of crowns was possible. Kesling foresaw that more ambitious tooth movements could be realized with a series of aligners, while recognizing thelimitations of the technology available to him at the time: 'Major tooth movements could be accomplished with a series of positioners by changing the teeth on the set-upslightlyas treatment progresses (Kesling,1946)[2].

Thirty years later, Ponitz (1971) [5]introduced an 'Invisible Retainer,' which used Kesling's idea of pre-positioning teeth on a master study model. Like Kesling's appliance, the 'Invisible Retainer' could only produce minor tooth movements, again achieving its results through the tipping of crowns.

In the early 90s, Sheridan described a technique of using clear aligners in conjunction with inter proximal tooth reduction Sheridan et al.(1993)[6]. The principle of producing minor tooth movements with individual aligners had not changed. Anew 'Kesling set-up' was required for every tooth movement, and therefore, a new impression was taken at almost every visit. This process demanded a large amount of clinical and laboratory time. Align technology released their Aligner H system in1999. It was the first orthodontic appliance to use computer- aided design (CAD) and computer-aided manufacturing (CAM).Insteadof requiring a new impression for each tooth movement, this technology allows for multiple tooth set-ups to be created from a single impression (Hajeer et al., 2004)

Advantages

Today there is a high demand for an esthetic orthodontic appliance . Aligner offers the advantages of superior esthetics and comfort as compared to all other appliances currently available[39].

Esthetics:

Clear Aligner Therapy usually performs well in following condition:[43]

- Mild crowded and mal aligned problems(1-5 mm)
- Spacing problems (1-5mm)
- Deep over bite(Class II div 2 cases)
- Narrow arches that can be expanded without tipping the teeth too much.
- Absolute intrusion (1 or 2 teeth)
- Lower incisor extraction for severe crowding cases
- Tip molar distally

Disadvantages

Use of the Aligner appliance is relatively new for orthodontists and is still being developed. Currently, few clinical studies and case reports have assessed the effectiveness of this technique. Although Align Technology has suggested guidelines for its appropriate use, clinicians have encountered numerous limitations when using the appliance.

Conditions that can be difficult to treat with an Inv is align appliance are:-

- Crowding and spacing over 5mm
- Skeletal anterior-posterior discrepancies of more than 2 mm (as measured by discrepancies in cuspid relationships)
- Centric-relation and centric-occlusion discrepancies
- Severely rotated teeth (more than 20 degrees)
- Open bites (anterior and posterior) that need to be closed
- Extrusion of teeth
- Severely tipped teeth (more than 45 degrees)
- Teeth with short clinical crowns
- Arches with multiple missing teeth.
- Prohibitively Expansive

In addition Clear Aligner therapy does not perform well in:

- Dental expansion or blocked-outteeth
- High canines
- Leveling by relative intrusion
- Molar uprighting (any teeth with large undercuts)
- Translation of molars
- Closure of premolar extraction spaces.

Tooth Movements With Aligner System

Bodily Tooth Movement

- Blocked-out incisor requires more space than can be obtained by stripping its proximal surfaces.
- Insert separators one contact away from the blocked-out incisor to create an open field for better visual access. See the patient no more than 5 days after placement.
- Use ARS to create space(0.5mm–.0mm).
- Use separators (slightly larger than in earlier Step) to move teeth into space created in previous step. Again, see the patient no more than 5 days after placement.
- Create a facial window (space within the appliance) for the tooth to move out of the blocked out position

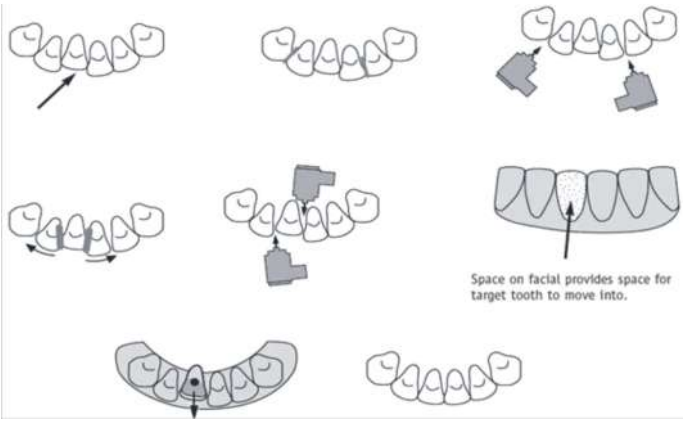

Figure 1 –BodilyTooth Movement

- Use Hilliard pliers to create force in 1mm increments tomove the tooth into the facial window. axillary Pliers #82520 bigger tip) is used for moving upper teeth. Mandibular Pliers #82530 smaller tip) is used for moving lower teeth.
- 24-hour wear, except while eating, is recommended. Estimated results are1mm per month.

Mesio-distal movement

- Triad gel #30009 s placed on the working model on the side of the tooth the lateral movement is to occur on. This creates a space, like a channel, in the thermo plastic for the tooth to move into when a force is created on the opposite side.
- This technique utilizes the Mesial- Distal Thermo pliers#82630
- The force for the desired movement is provided by either of the following methods:

A. A bump preparation in the plaster on the distal of the incisor.
B. A bump formed in the thermoplastic with the Mesial-DistalThermopliers after the appliance has been fabricated.

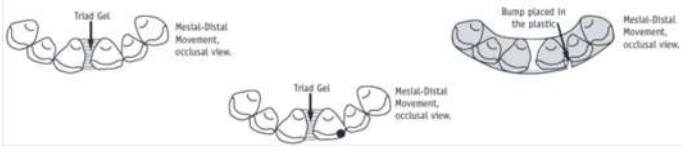

Figure 2 -Mesiodistal Movement

- Additional force from a larger bump in the thermoplastic (either at insertion or at subsequent adjustments) can be made with the appropriate Hilliard Thermopliers.
- The Bubble-Bump technique allows several teeth to be moved at the same time in the mesial distal direction. The capability to move in the mesial-distaldirection can be combined with other movements on the same appliance to allow movement of teeth in all three planes of space.

Rotation

The depth and position of the bump and space in this technique are dictated by the amount of and type of rotation the clinician wants. This technique utilizes the micro-ramp Thermopliers #82560.

- Insert separators on either side of the tooth to create an open field for inter proximal reduction.
- Use ARS to create additional space between teeth.
- Construct an Es six appliance over the working cast.

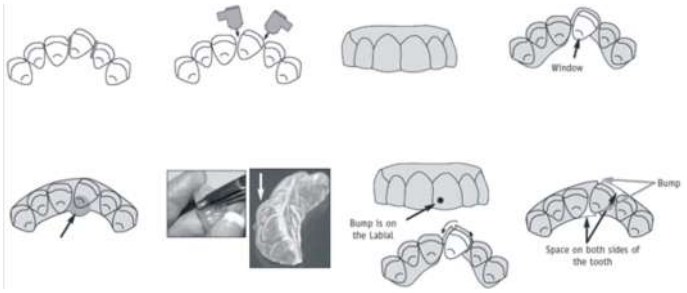

Figure 3 -Rotation

Torquing

- Construct an Es six appliance over the working cast.
- Create space for the tooth to move leaving an incisa ledge cap.
- Using the maxillary Pliers #82520 place a 1mm bump near the gingival border. (For lower teeth, use the mandibular Pliers #82530) Use the micro-ramp Pliers #82560 o induce a bump close to the gingival margin if the maxillary and mandibular Pliers are toothick.

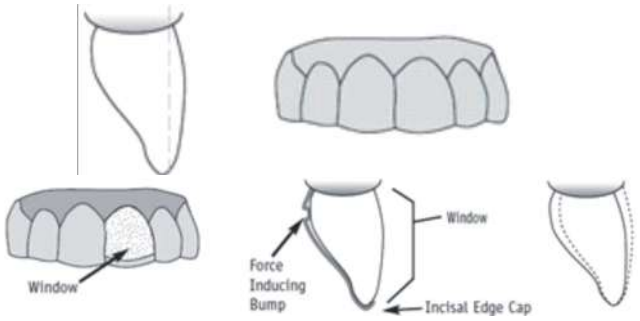

Figure 4-Torquing

Anterior Intrusion

In order to intrude a tooth using an Es six appliance, relief must be provided on the lingual and labial surfaces of the target tooth in the appliance. Then a bump is created on the occlusal surface of the target tooth. The goal is to have light, continuous force on the target tooth as opposed to heavy pressure. The relief allows this to happen. Triad gel #30009s added to the working model to provide this relief.

Intrusion adjustments work well on a single tooth. It is possible to Intrude two teeth at the same time but it becomes progressively more difficult to seat the appliance if more than two teeth are intruded at the same time.

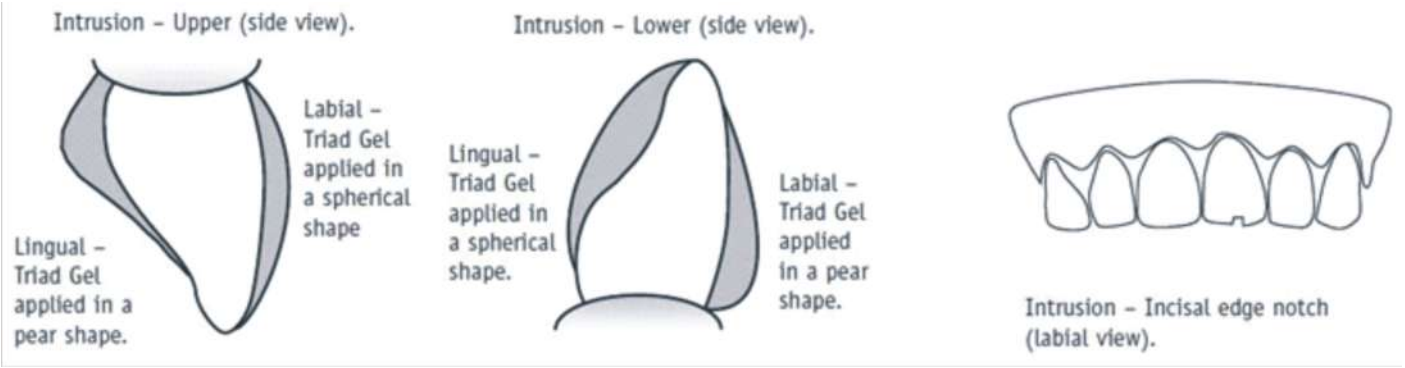

Figure 5- Anterior Intrusion

It may be necessary to increase the retention of the Es six appliance if there is not sufficient retention.

The pathway for the tooth that is to be intruded needs to be clear of obstruction. ARS, separators or tooth movement may be necessary before the impression is taken for fabrication of the intrusion appliance

The Invisalign Process

The Invisalign process involves several steps. The first step is the gaining of complete patient records from the treating Orthodontist. Once received at Santa Clara the records go through a series of steps from scanning to case setup and then back to the clinician for a review called Clincheck. The process of manipulating virtual tooth movements is complete when the clinician approves the Clincheck. Once the Clincheck is approved, the aligners are processed and sent to the clinician.

Polyvinyl Siloxane (PVS) Impression:

An essential component of the Invisalign process is getting an accurate representation of the teeth. PVS was chosen because it provided the greatest degree of accuracy and stability. Tests are currently in progress to evaluate an alginate based material that can provide the accuracy and stability of PVS while allowing easier and the more efficient handling.

Scanning

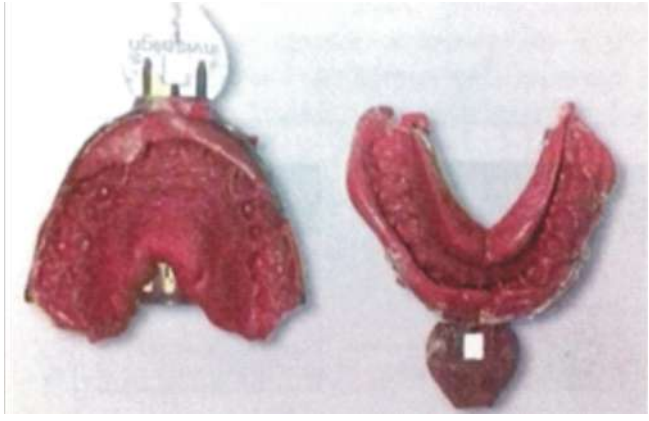

Figure 6- One step PVS impression

Bite Registration:

To accurately capture the occlusion of the two arches together, a bite registration is required . The bite registration is based on centric occlusion because a virtual typodent with a virtual hinge axis is not currently available

Figure 7- PVS registration

Figure 8- Bite registration

Treats of Tware:

After the bite has been established, an Invisalign virtual orthodontic technician uses software to cut the virtual models and separate the teeth, thus allowing them to be moved individually.

In early 1997 the software component of Invisalign were broken into two parts: CLIPPER and ALIGNER. The clipper package allows a user to cut a virtual dental model into multiple pieces, each one representing a tooth. The aligner package takes the virtual model created by the clipper and allows a user to move the teeth in final position. Aligner also defines how the teeth will move into those positions overtime.

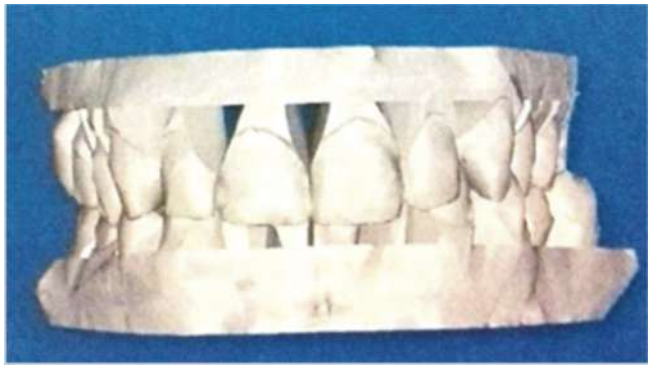

Figure 9- Early image with no virtual gingiva

Figure 10.Current image with virtual gingiva

Aligner Production:

Once the clinician approves the Clincheck, the three dimensional computer images are converted to physical models using a process called rapid proto typing. Specifically, stereo lithography is the rapid prototyping technology used to create the models. These models are used to fabricate the aligners on a Biostar (schue – dental)pressuremoldingmachine.

The concept of moving teeth with clear overlay appliances has been around since 1926. Align technology is the first company to incorporate modern technology in a way that makes this concept a feasible, viable, efficient and effective orthodontic treatment option. The Invisalign process has evolved and improved since 1997 and even today continues to change and adapt to better meet the needs of clinicians and their patients.[1]

Figure 11. Bio star machine

Figure 12. Stereo lithography model

Figure 13. Pressure-formed Aligner over the Stereo litho graphic model

Conclusion

In this era of 21st century, the number of adult patients seeking orthodontic treatment are increasing day by day. Fixed orthodontic appliance have been the spine of orthodontic bio mechanical technique. The appliances used today have evolved since Angles' Edgewise appliance. In 2017, White D. W, et al concluded in his study that Traditional fixed appliances produced significantly more discomfort than do aligners. During the first 3 days after bonding, there was significantly more discomfort when chewing than when at rest for patients treated with traditional appliances. Patients treated with aligners and traditional appliances reported significantly less discomfort at subsequent adjustments than after the initial bonding or appliance delivery.

In addition to this two major plastic tooth moving appliances, various other system like Clear Correct, MTM Clear Aligners, Clear Path Orthodontics, Clear Step, K-Ligner are promoting their plastic tooth moving appliances in various ways. This radical concept of esthetic plastic appliance for comprehensive orthodontic treatment needs additional research and refinement of the design which should allow further development of this worth while treatment.[9]

In Conclusion our findings are that Over the last 16 years, clear aligner treatment has developed from a technique of only treating mild crowding or spacing of anterior teeth to a technique that can be used to treat almost any type of orthodontic problem. However to do so, one needs to understand the limitations of the appliance and to able to think “out of the box” in treatment planning. Aligner materials and attachments will continue to improve which will allow aligners to fit better and for longer periods of time and result in better outcomes. Research into tooth movement and particularly tooth movement mechanics with aligners and the variation in these movements will allow further development of computer algorithms that are used in sequencing aligner tooth movement. Even so, with the amount of variation that is seen in orthodontic treatment, it will always take a knowledgeable practitioner to treatment plan and monitor treatment with alignes..

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A Series-Part 1

Bone Loss, Its Patterns & Rationale of Bone Grafting

Dr. Nymphea Pandit[1]
Dr. Inder Kumar Pandit[2]

MDS, Ph.D[1]
Professor and Head,
Dept. of Periodontology & Oral Implantology,
J.N. Kapoor DAV (C) Dental College,
Yamunanagar, Haryana.

MDS[2]
Principal, Professor & Head,
Dept. of Pedodontics & Preventive Dentistry,
J.N. Kapoor DAV (C) Dental College,
Yamunanagar, Haryana.

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The final and most severe effect of the inflammatory process seen in periodontitis is bone loss. In periodontitis, the inflammatory reaction to the bacterial biofilm insult damages the periodontal unit and causes bone loss as well as the breakdown of periodontal ligament fibres. As a result of previous pathologic episodes, the bone loss takes place but soft tissue changes may or may not correspond to it. Therefore, the depth of periodontal pockets, the severity of pocket wall ulceration, or the presence or absence of suppuration do not always correspond with the degree of bone loss.

The ultimate indicator of bone health is bone loss rate.

When periodontal disease was allowed to worsen untreated, **Löe & colleagues** discovered that the average rate of bone loss for facial surfaces and roughly 0.3 mm per year for proximal areas.

Never the less, depending on the condition that is present, the pace of bone loss may change. On the basis of inter proximal loss of attachment and tooth mortality (loss of attachment can be equated with loss of bone, although attachment loss predates bone loss by around 6 to 8 months), **Löe and colleagues**[1] also found the following three subgroups of individuals with periodontal disease:

1. Approximately 8% of persons had a rapid progression of periodontal disease that was characterized by a yearly loss of attachment of 0.1 mm to 1 mm.
2. Approximately 81% of individuals had moderately progressive periodontal disease with a yearly loss of attachment of 0.05 mm to 0.5 mm.
3. The remaining 11% of persons had minimal or no progression of destructive disease with a yearly loss of attachment of 0.05 mm to 0.09 mm.

Factors affecting the morphology of osseous defects:

The form of the osseous defect depends on the location of causative microorganisms on the root surface, form of dental arches and vascular pathways, root and root trunk anatomy, thickness of alveolar bone root position within alveolar process and the proximity with adjacent involved root surface. In wide arches, craters and intrabony defects predominate, and in the narrow arches, the margin is destroyed leading to the formation of inconsistent margins which may be associated with an interproximal crater or a hemiseptum. At the base, which is wider than the crest, the infrabony defect may develop only at the apical third of the root.[2]

There are two general theories about the determinants of site and morphology of bone defects:[2]

1) Form of the defect is related to occlusal stress on the related teeth or tooth **(Glickman and Smulow 1962)**[4]
2) Form of the defect is related to the original anatomy of alveolar process **(Prichard 1965)**[5]

The potential relationship of occlusal trauma to the severity and/or progression of periodontal disease have been documented in the past literature with no clear conclusion. Polson and Zande[6] concluded that trauma superimposed upon existing intrabony pockets increased loss of alveolar bone and altered osseous morphology, but did not affect the loss of connective tissue attachment. Also no association has been documented between increase in probing depth in the presence of occlusal discrepancies.[7] The role of occlusal trauma in the etiology of periodontal disease has been strongly associated with other factors such as oral hygiene and smoking. Traumatic occlusion may play only a secondary function in the initiation and progression of periodontitis.[8-11]

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Goldman & Cohen (1958)[12] have included traumatic lesions of the attachment apparatus among the other possible factors in the pathogenesis of the bone defects like tooth anatomy and position, the relationship of adjacent marginal ridges and cemento enamel junctions and open contact points with resultant food impaction.

The Different Classification Systems Describing The Various Types Of Defect

Having a thorough knowledge about the morphology would help the clinicians in ideal decision making regarding the techniques and materials used for regeneration. For example, a defect with more bony walls would present with more osteogenic surface area, and lead to a predictable regeneration with or without bone grafts.

Osseous defects in periodontitis have been broadly classified into Horizontal bone loss and Angular bone loss. Horizontal bone loss is the most common pattern of bone loss in periodontal disease. The bone is reduced in height, but the bone margin remains approximately perpendicular to the tooth surface. Such a shallow linear defect between marginal bone of the radical cortical plate or interdental crest, extending the length of one or more root surfaces, usually formed by socket side resorption and deposition of facial surface known as marginal gutter.

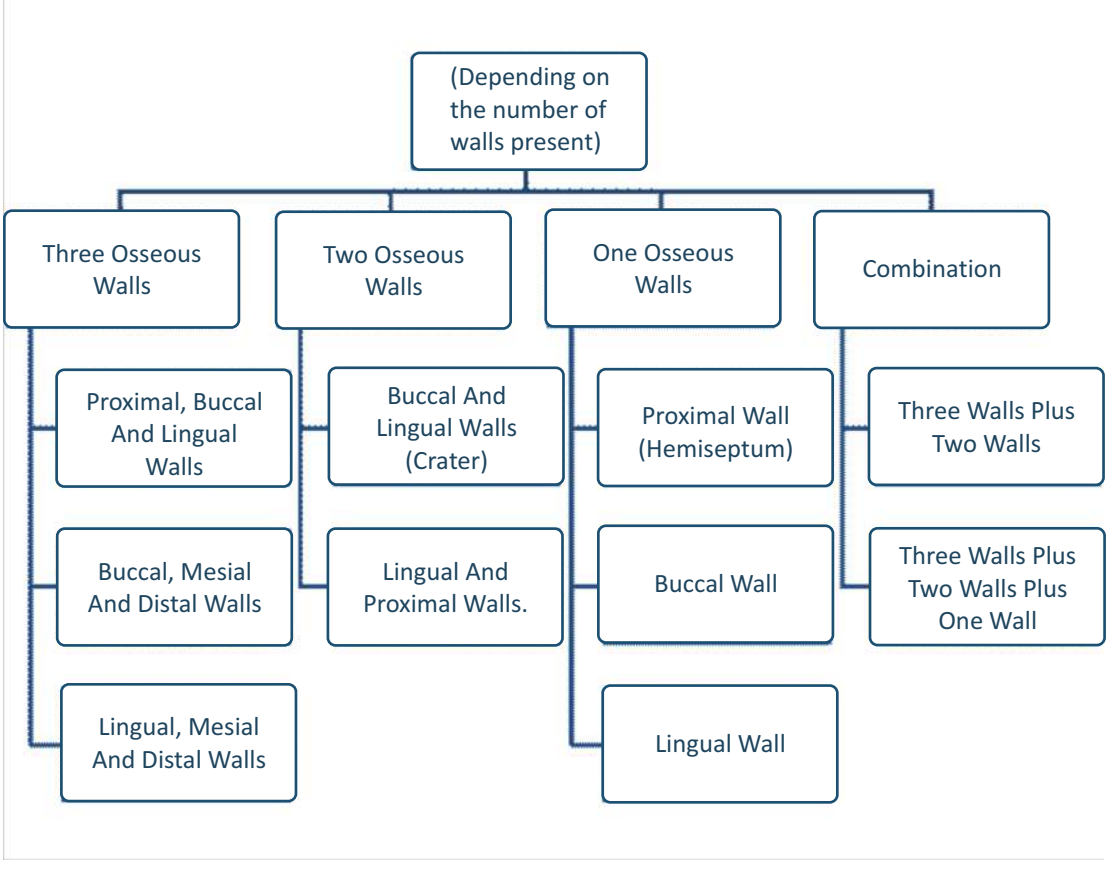
Vertical or angular defects are those that occur in an oblique direction, the base of the defect is located apical to surrounding bone.[13]

Suprabony defects are those where the base of the pocket is located coronal to alveolar crest. Infrabony defects are defined by the apical location of the base of the pocket with respect to the residual alveolar crest. Another term that has been used in the literature is the intrabony lesion. The terms Infrabony and intrabony have been used interchangeably in the periodontal literature. In a recent guest editorial by **Mea A. Weinberg & Robert N. Eskow,** have designated the term Infra bony periodontal defects as all angular or vertical periodontal defects and intrabony defects as specific type of 3- wall condition with specific morphology and a higher potential for regeneration than other types of bony defects.[14]

The definitions in the classification systems are not based on the radiographic assessments but on the actual morphology of the defects after flap elevation.[2]

Goldman &Cohen (1958)[12]:

It is one of the most commonly used systems till today. They classified the vertical defects on the basis of the number of remaining walls.




Glickman (1964)[15]:
Described bone deformities as:

- Osseous craters
- Infrabony defects
- Bulbous bone contours
- Hemisepta
- Inconsistent margins
- Ledges

Osseous craters: These are concavities in the crest of the interdental bone confined within the facial and lingual walls.
Infrabony defects: These are hollowed out troughs in the bone alongside one or more denuded root surfaces, enclosed with one, two, three or four bony walls.

Bulbous bone contours: Bony enlargements caused by exostoses, adaption to function, or buttressing bone formation.

Hemisepta: The remaining portion of an interdental septum, after the mesial or distal portion has been destroyed by periodontal disease.

Inconsistent margins: These are angular or U - shaped defects produced by resorption of the facial or lingual alveolar plate, or abrupt differences between the height of the facial or lingual margins and the height of the interdental septa.

Ledges: These are plateau-like bone margins caused by resorption of thickened bony plates

Prichard's Classification (1966)[16]

He included in his classification furcal invasion and combinations of one, two and three walled pockets. Defects in interalveolar bone were classified as:

- Interproximal craters
- Inconsistent margins
- Hemisepta
- Furcation Involvement
- Intrabony defects (infrabony defects with three osseous walls)
- Combination of these defects

Crater was defined as a wide mouthed cup or bowl shaped defect in the inter alveolar bone, with bone destruction about equal on the roots of the contiguous teeth; the side walls of the crater are formed by marginal bone on the vestibular and lingual surfaces.

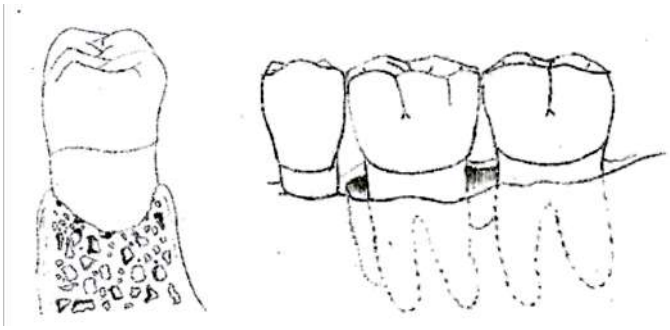
The intrabony defect is a specific osseous defect with definite morphology; it is not just any defect with the base of a periodontal pocket apical to the alveolar crest.

Karn et al (1983)[17]

He gave a topographic classification of deformities of the alveolar process as:

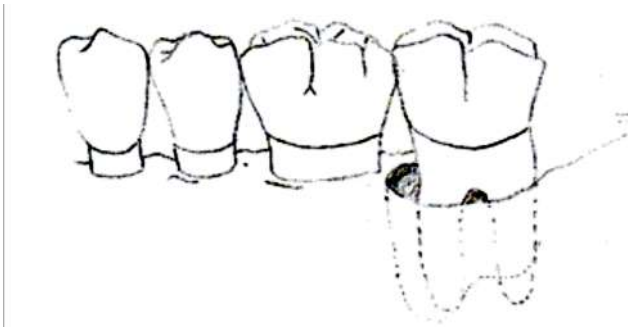
- Crater
- Trench
- Moat
- Ramp
- Plane/ Horizontal bone loss
- Cratered ramp
- Ramp into a crater or trench

Crater: A crater is formed as a result of loss of alveolar bone and a portion of the contiguous supporting alveolar bone from only one surface of a tooth.



Faciolingual cross section of crater Facial view of crater

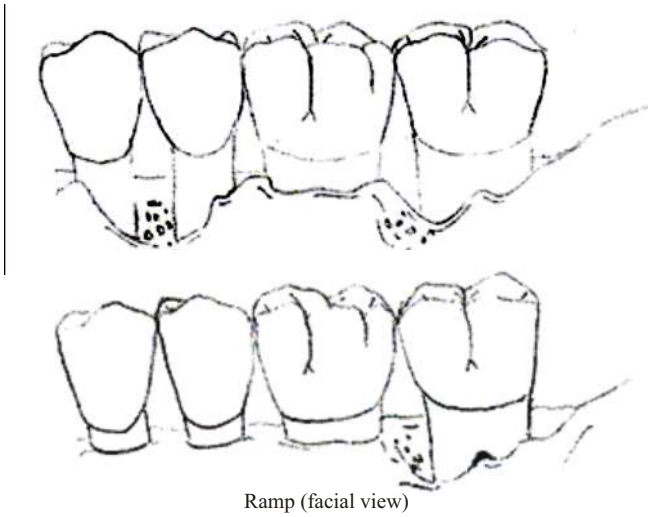
Trench: Is when bone loss affects two or three confluent surfaces of the same tooth. Trenches can be similarly identified by the tooth surfaces involved (e.g., mesiofacial, mesio-lingual-distal, etc.).



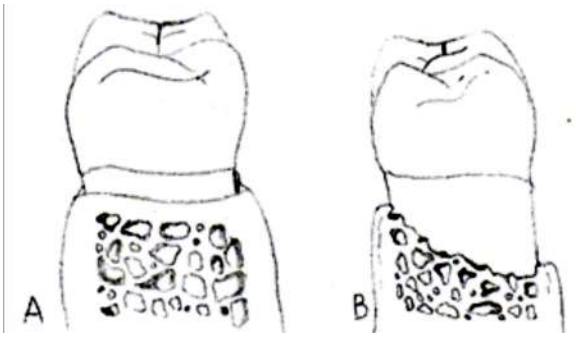
Trench

Moat: When the previously described deformity involves all four surfaces of a tooth, it is described as a moat.

Ramp: In its purest form the term ramp describes a deformity that results when both alveolar bone and its supporting bone are lost to the same degree in such a manner that the margins of the deformity are at different levels.



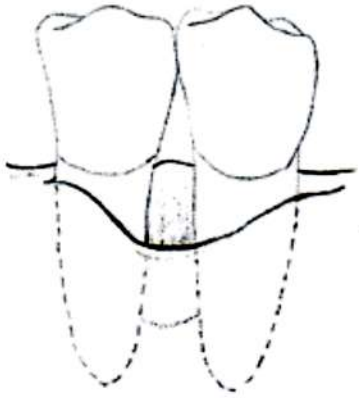
Ramp (facial view)



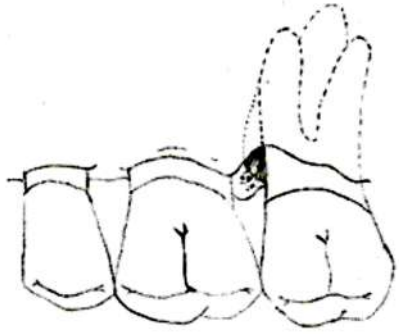
Mesiofacial ramp in a cross section of crater

Plane: This term is applied when both alveolar bone and supporting bone is lost to the same degree such that the margins of the deformity are at the same level. It can be considered horizontal bone loss about one tooth or portion of a tooth.

Cratered ramp: It is basically a crater with a portion of its facial and/or lingual wall missing. Cratered ramps are named for the teeth involved, the aspect of the alveolar process from which bone has been lost in the ramp portion and the tooth inter proximally, may also be seen facial and lingual to the teeth.



Cratered ramp



Mesial ramp into crater

Ramp into a crater or trench: The most coronal aspect of the deformity is distinctly a ramp and the apical portion is distinctly a crater or trench.

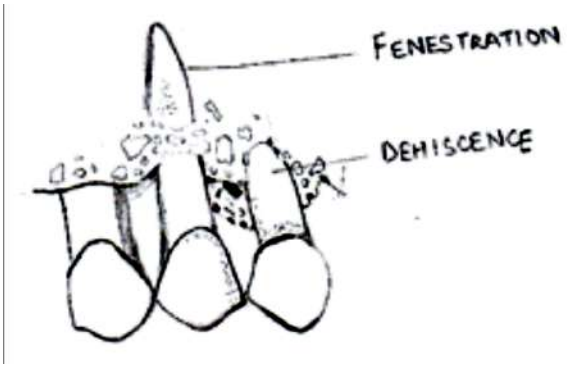
Furcation invasions: Descriptions of furcation invasions should include a notation of the degree of involvement (Class I, II or III).

Fenestration is a circumscribed defect in the cortical plate which exposes the lingual or facial root surface.

In fenestration and dehiscence a connective tissue covering overlies the osseous lesion and is firmly attached to the root surfaces by periosteal fibers[18,19]. During the surgery a fenestration can become dehiscence due to removal of the necrosed remaining thin layer of marginal bone.[21] Thus these defects are regarded as therapeutically tricky.

Circumferential defects classification:

In 1966, Wade evaluated the flap operations for correcting the osseous defects his report stated that repair may depend on circumferential aspect of the infra bony defect and the selection of the cases was recommended with particular regard for circumferential topography.[20] So a classification system was developed in an effort to expedite the portrayal of the horizontal surface aspect of most periodontal deformities by **Jules**

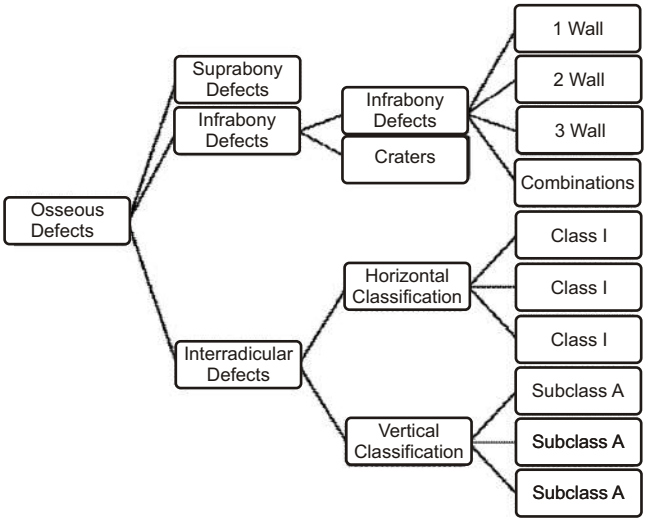


Klinsberg (1979)[21]

Klinsberg[22] proposed a classification with four aspects namely periodontal pockets, gingival recession, osseous pockets and osseous recession. He divided them mostly into four classes depending upon the number of surfaces and corners involved by the periodontal disease.

Papapanou P N et al 2000[2]

He has enlisted all the commonly used and most popular classification system for each category. For the osseous defects he included the supra bony and infrabony (according to **Goldmen and Cohen)**[12] and the furcation involvement classification by **Hamp et al** (horizontal component)[23] **and Tarnow & Feltcher**[24] (Vertical component) as a first level of classification for the periodontal defects.



Furcation Defects Classification:

Most of the classifications related to the furcation areas depend upon the extent of bone loss in the radicular area of the furcation. The modifications later on introduced included the vertical component of bone loss along with horizontal component.

Glickman classification (1953)[25]

Glickman was one of the first to classify furcation invasions based on the degree of lateral penetration of the periodontal destruction under the roof of the furcation. He divided them into the following four grades:

Score	Criteria
Grade-I	I. Incipient ii. Pocket is suprabony and primarily affects soft tissue. iii. Early bone loss with increase in pocket depth.
Grade-II	i. Can affect one or more furca of tooth. ii. Cul-de-sac with definite horizontal components. iii. Multiple defects do not communicate as a portion of alveolar bone remains attached to the tooth. iv. Extent of horizontal probing decides early or advanced lesion. v. Radiograph may or may not depict. iv. Presence of furcation arrow indicates possible furcation involvement.
Grade-III	i. Bone is not attached to furcation dome.. ii. Opening may be filled with soft tissue in early stage. iii. Probe may not completely pass through furcation because of interference with bifurcation ridge or facial / lingual bony margins. iv. Buccal and lingual probing dimensions equals furcation dimensions.
Grade-IV	i. Interdental bone destroyed. ii. Soft tissue receded apicall y to furcation opening, visible clinically. iii. Funnel exists between the furcation and probe passes readily

Goldman et al classification (1958) [25]

- Grade I Incipient.
- Grade II Cul-de-sac.
- Grade III Through-and-through.

Hamp et al (1975) [23]

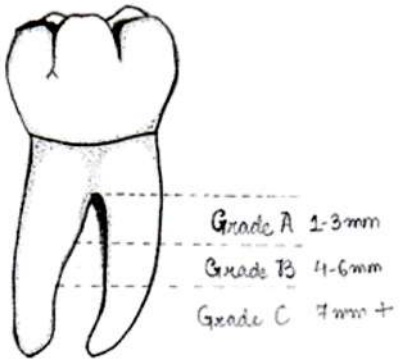
Hamp et al modified the **Lindhe and Nyman** classification by adding the component of prognosis for the treatment modalities.

- **Degree I**
  - o Horizontal loss of periodontal tissue support not exceeding one third of the width of the tooth.
- **Degree II**
  - o Horizontal loss of periodontal support exceeding one third of the width of the tooth, but not encompassing the total width of the furcation area.
- **Degree III**
  - o Horizontal through-and-through destruction of the periodontal tissue in the furcation.

Tal and Lemmer (1982)[27]

Vertical component of the classification was added to predictably determine the prognosis for various treatment modalities. The degree of severity of the furcation defects affecting each molar is assigned to one of four groups designated 1, 2, 3 and 4, referred to as furcation involvement index (FII) scores.

- Furcal rating 1. Depth of the furcation is 0 mm.
- Furcal rating 2. Depth of the furcation is 1 to 2 mm.
- Furcal rating 3. Depth of the furcation is 3 mm.
- Furcal rating 4. Depth of the furcation is 4 mm or more.



Tarnow & Fletcher (1984)[24]

Each grade of furcation is further subdivided into three subgroups, based on the degree of vertical involvement.

- Subclass A 0–3 mm
- Subclass B 4–6 mm
- Subclass C >7 mm

Fedi (1985)[28]

Combined Glickman and Hamp classifications: Grades are same as Glickman's grades I through IV, but grade II is subdivided into degrees I and II.

Degree I

The furcation bone loss possesses a vertical component of >1 but 3 mm, but still does not communicate through-and-through.

Walter et al. (2009)[29]

They modified the **Hamp et al** classification by adding a specific digital number to delineate different classes

Degree II is divided into:

- **Degree II.**
  - o Horizontal loss of support >3 mm, but no more than 6 mm.
- **Degree II–III:**
  - o Horizontal loss of support >6 mm, but no detectable "through-and-through" destruction.

Classification of Peri Implant Defects:

It is necessary to classify the peri implant defects and have a thorough knowledge of the configuration of these defects so as to help the clinician to decide whether to carry out a resective or regenerative therapy as may be applicable for defect filling.

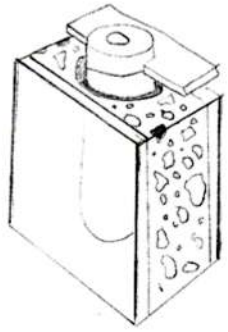
Spiekermann Classification (1984):[30]

Classified the peri implant defects on the basis of the clinical status of the peri implant bone and the required therapy.

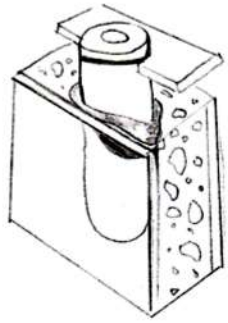
- Class I- Horizontal
- Class II- Key-shaped
- Class III a-Funnel-defect
- Class III b- Gap-like defects
- Class IV- Horizontal-circular

Spiekermann classification (1995):[31]

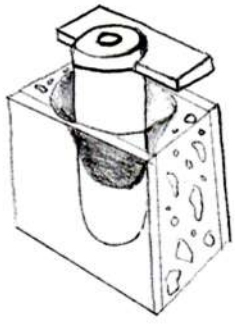
- **Class I**
  - Slight horizontal bone loss with minimal periimplant defect
- **Class II**
  - Moderate horizontal bone loss with isolated vertical defects
- **Class III**
  - Moderate to advanced horizontal bone loss with broad circular bony defects
- **Class IV**
  - Advanced horizontal bone loss with broad circumferential vertical defect as well as loss of oral and/ or vestibular bony wall.



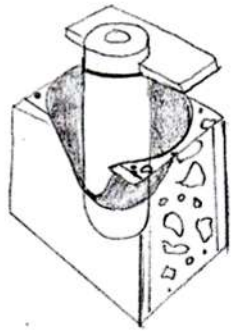
Type I



Type II



Type III



Type IV

Vanden et al (2004):[32]

- **Type 1 defect:** Closed defect
  - The surrounding walls are maintained
- **Type 2 defect:** Open Defect
  - Which lack one or more bone walls

Schwarz et al 2008:[33]

- **Class I defects**
  - Intraosseous defects
- Class II defects
  - **Supra-alveolar defects**

Prevalence:

Periodontal Defects:

Bony defects prevalence has been reported to be 18% (Nielsen)[34], 32% (**Wouters and Salonen 1988**)[35], 60.8% **(Persson 1998)**[36], 45% **(Soder et al)**[37], 51% **(Ainamo et al 1998)**[42].

Osseous craters have been documented as the most common intrabony defects and comprised 62% of all the bony defects in the mandible. **(Manson and Nicholson 1974)**[43] also reported by **Saari et al**[44] the highest prevalence was of craters (5.35%) followed by intrabony defects (4.10%) and hemisepta (0-5%).

Age:

Higher prevalence of bony and furcation defects has been noted in older age. **(Nielsen, Papapanou et al, Wouters et al)**[38, 45,46]

The frequency of crater defects increased with age. **(Gilmore 1970, Larato 1970, Nielsen et al 1980)** [47,48,38]

In terms of location:

Craters have been found mostly between the 2nd and 3rd molars. Usually the heights of the lingual and buccal crest were equal in 85% of craters **(Saari et al)**[44], if unequal then the buccal crest were located apically than the lingual crest.

In case of hemiseptal defects the mesial surfaces of roots were more involved than distal roots[49]. Same was reported by Muller et al[50] who stated the prevelance of the intrabony defects deeper on mesial than on distal which was in accordance to other studies by **Persson and Wouters FR.**[40,46]

Fenestration were more common in maxilla (37% in maxillary1st molar, 13.9% in maxillary canine and 11.5% in mandibular canine) while dehiscence was more commonly seen in mandible (12.9% in cuspids, 11.3 % left maxillary molar)[51]

Furcation has also been reported to have higher prevalence in maxilla than mandible. Highest prevalence of class 2 and class 3 was observed at distal site of maxillary first molar (53%) and least in mesial aspect of maxillary second molar.[52]

Diagnosis:

The detection and accurate assessment of the location, extent and configuration of the endosseous defect is important for determination of the tooth prognosis, the treatment plan and maintenance procedures **(Papapanou&Wennstrom 1991)**[53]

Visual Examination:

The exact topography of the alveolar process affected by periodontal disease can be determined only by visual examination during surgery. It can be done by two methods: one by Open Bone Measurements Using Probe and another is Impression Method.

Probing:

Careful probing during clinical examination is essential and pocket depth and width can be determined, but there are limitations and probing does not verify the precise position of the bone.

Bone Sounding:

This method is a trans-gingival probing technique that is used, under anesthesia, to plot the morphological outline of the defect. Because bone sounding gives consistent measurements that are equivalent to open bone measurements, and in addition avoids a re-entry procedure, it can be considered as a good substitute for open bone measurements.

Radiographs:

The IOPAs show the vertical position but not the width of the alveolar process in the septal regions. The appropriate depth of absorption may be seen, but neither the width of septal bone nor the buccolingual position of the deformity can be recorded.

It's difficult in identifying subtle osseous changes[54-57] **(Goldman, Prichard, Bender, Ramadan)**, due to the presence of structured noise which consists of anatomic features that are not of specific diagnostic interest.[58]

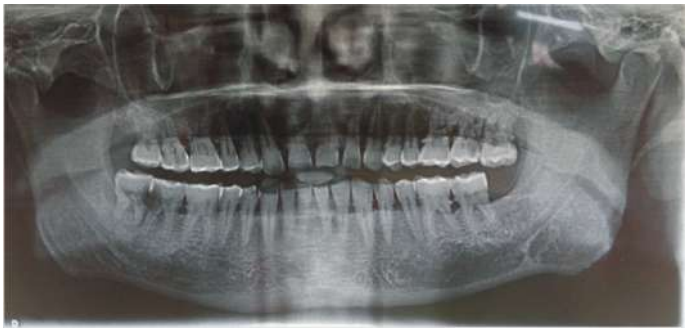
Other shortcomings are elongation of the radiographic image. The image may apparently "grow or destroy" alveolar bone independent of any real change in the alveolar bone support. Variations in the contrast and density of a radiograph, caused by poor control of film processing, or variation in KVp or exposure time, may burn out the alveolar crest independent of changes that are in the two-dimensional nature of conventional radiograph.[59]

Periapical radiographs are susceptible to operator error, especially in maxillary molar region. **(Hausmann 1989)[60].** Using a radiographic grid and Schei ruler have been employed to reduce the discrepancies.[59]

Comparison of the radiographic and direct measurements showed that they were equal or differed by ±1 mm in 140 pairs (87.5%) of measurements.[61]

Panoramic Radiography:

Advantage of using panoramic radiographs is a large amount of information while exposing the patient to low level of ionizing radiation. **(Gonzalez 2001).**[62] One of main limitations is the potential for image distortion (Mol A).[63] In patients with Chronic Periodontitis and Aggressive Periodontitis, panoramic radiographs often under or overestimate linear distances. A study by Kim ST stated that panoramic radiographs may be an alternative to the set of intraoral radiographs but cannot replace them.[64]



Digital radiography & Subtraction radiography:

Subtraction radiography reduces structured noise, increases the detectability of radiographic changes and improved diagnostic accuracy.[65]This technique permits visualization of change in image densities at different time intervals and allows detection of mineral changes as little as 5%.[66]

The two technical obstacles to clinical implementation of this technique include the use of unwidely custom occlusal templates and the need for computer assistance.[65]

The radiation dose is reduced to 80-96% in direct digital method. When such systems are coupled with image processing computers and mass storage devices such as optical disks, the comparison of multiple radiographic examinations is facilitated.[65] CADIA (Computer-assisted densitometric image analysis) method has been applied and it presents bony changes in terms of CADIA units which are related to the gray level changes.[67]

Computed Tomography:

CT has been explored as it enables cross-sectional and three dimensional analysis without distortion. But CT is impractical because of machine cost, complexity, high radiation and relatively low resolution.[68]

In addition DVT (digital volume tomography) than offers better imageing quality than CT but with a slight deviation in the dimension.

More recently, Cone beam computed tomography (CBCT) was introduced for head and neck application.[69-73] CBCT examination takes approx 30 seconds, and radiation is within range of an intraoral full-mouth series[74,75]. The CBCT measurements are comparable to traditional methods, with advantage of allowing observance of periodontal defects in all directions.[68]

These advances in radiography reduce the radiation exposure but their utility in periodontal and periimplant defect diagnosis is less due to the cost factor.[68]

Fiberscopes:

Fiberscopes are based on fiberoptic endoscopy technology, and they are minimally invasive miniature periodontal endoscopes with which a magnification of 24-48X can be achieved. Fiberscopes, when applied clinically as reported by **Ozawa et al. (1999)**[76] allowed visualization of the fields involved in periodontal disease. When inserted through a fistula, the extent of bone loss, the soft tissues and root surfaces involved in periodontal lesions could be differentiated. It can also be applied to furcation diagnosis; however, to date there are no studies conducted to assess the efficacy of fiberscopes in furcation measurements.

Optical coherence tomography (OCT):

The optical coherence tomography system uses a white light that is able to penetrate into the tissues without biologically harmful effects. Differences in the reflection of the light are used to generate a signal that corresponds to the morphology and composition of the underlying tissues. It has been reported to be a novel diagnostic device and as a sensitive method for identifying periodontal defects (Otis et al., 2000)[77]. This system is implicit to be able to provide both 2- and 3-dimensioal intraoral images with good lateral and axial optical resolution and good microstructural detail.[78]

Ultrasonography:

It is a non-invasive investigation technique that uses a very high frequency (7.5-20 MHz) pulsed ultrasound beam to produce high-resolution images of structures. As the ultrasound waves travel through the tissues, some of them are reflected back by tissue interfaces to produce echoes that are picked up and converted into electrical signals, which in turn are converted into black, white and grey images and are displayed on a computer screen. Using ultrasound in osseous defects diagnosis, a study by **Chandra shekhar et al. (2014)**[79] showed that it was 76% accurate as compared to surgical measurements (clinical measurements showed 70% accuracy). Further studies, however, are required to substantiate its effectiveness in osseous defects measurements.

Clinical Significance:

The Regeneration Potential Score (RPS) of the defects can be calculated by the no. of osseous defect walls present for the predictability of the regeneration.

For vertical defects:

Type of Defect	Vascularized Osseous Walls		Flap Interface		Root Surface Walls		R.P.S
3 Osseous Walls	3	+	1	-	1	=	3
2 Osseous Walls	2	+	1	-	1	=	2
2 Osseous Walls	2	+	1	-	2	=	1
1 Osseous Walls	1	+	1	-	1	=	1

For Furcation defects:

Type of Defect	Vascularized Osseous Walls		Flap Interface		Root Surface Walls		R.P.S
Crestal Lesions	1	+	1	-	2	=	0
(Inter-Proximal Facial & Ingual Dehiscence)	0	+	1	-	1	=	0
Class II Furcations	2	+	1	-	3	=	0
Class III Furcations	1	+	1	-	3	=	-1

Rationale of bone grafting:[70]

The results of systematic reviews and meta-analysis show that

1) In comparison to open flap debridement (OFD) operations, bone grafts raise the bone level, decrease crestal bone loss, increase clinical attachment level, and minimize probing depth;
2) There are no differences in clinical outcome parameters between calcium phosphate (hydroxyapatite) ceramic and particulate bone allograft grafts; and
3) compared to graft alone, bone grafts with barrier membranes increase clinical attachment level and decrease probing depth.

Using grafts to treat Class II furcations had positive therapeutic outcomes. 3Demineralized freeze-dried bone allograft (DFDBA) supports the development of a new attachment apparatus in intrabony defects, whereas OFD causes periodontal repair that is primarily characterised by the growth of a long junctional epithelial attachment.

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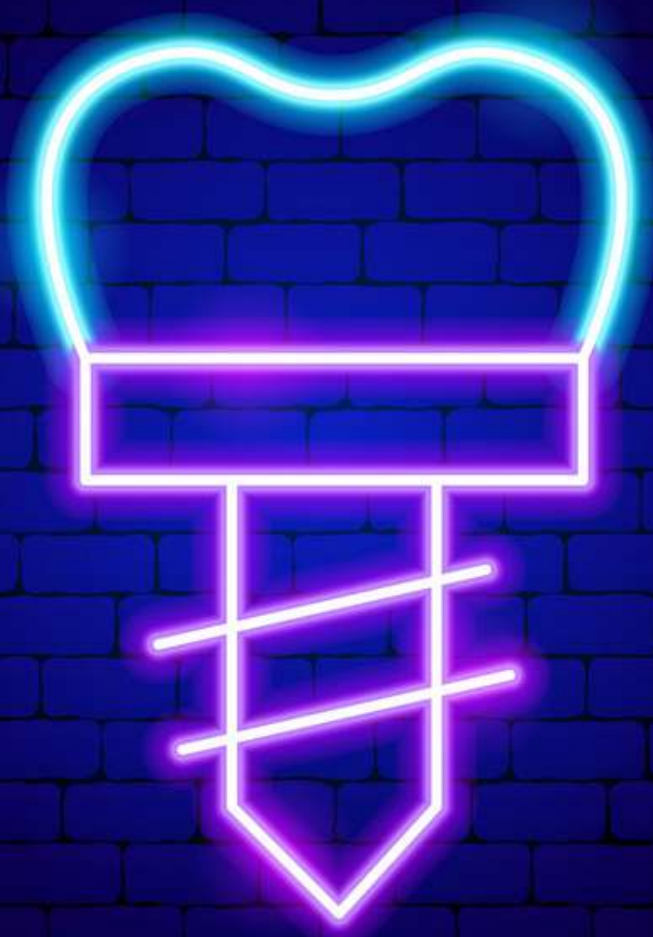

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