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Editorial

In 1980, in the journal *Science*, Walter Alvarez and his colleagues published a scientific article describing their controversial new hypothesis that the dinosaur extinction was triggered by a massive asteroid impact. Despite its splashy and novel topic, the article laid out its hypothesis and evidence in the conventional way — which allowed colleagues to quickly evaluate the research. Alvarez stumbled onto his hypothesis unexpectedly, originally setting out to study the tectonic movements of the Italian peninsula. After an intriguing series of twists, turns, false starts, inspirations, and rejected hypotheses, he and his colleagues found that they had completed a rather different, but compelling, investigation.

Scientific ideas are tested with multiple lines of evidence. Science relies on communication within a diverse scientific community. Journals distribute scientific information to researchers so that they can keep current in their fields and evaluate the work of their peers. Publishing in scholarly journal is considered by many as a means of intellectual dissemination. A journal is always the attraction of authors/researchers for publishing their article-whether the journals has any significant impact factor or not. Publication is a fact of life and vital to growth of science and career progression. A novel idea published can be time tested and be proven right or wrong. The key word is “to publish or perish!”

Dr. Pradeep Kumar. C
(Principal)
Chief Editor

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EFFECT OF POLYSORBATE ON ANTIBACTERIAL EFFICACY OF THREE ROOT CANAL SEALERS AGAINST ENTEROCOCCUS FAECALIS: AN IN VITRO STUDY

Dr. Muhammad Rashid.P.A, **Dr. Mohammed Sadique.K.P, ***Dr. Elsy P.Simon, ****Dr.Ravi.S.V, *****Dr.Sandeep Lal, *****Dr.Mohammed Ashik P

Abstract

Aim and objectives : The aim of this in vitro study is to compare the effect of polysorbate on the antibacterial efficacy of calcium hydroxide based (Apexit plus), zinc oxide eugenol based (Endomethasone) and resin based (AH-Plus) root canal sealers against *Enterococcus faecalis* microbial culture collection (MTCC) 439 using agar diffusion test.

Materials and Methods: Microorganism was grown at 37°C for 24hrs in MH broth and seeded into MH agar to produce a turbidity of 0.5 on the McFarland's scale. 20 Mueller Hinton agar (MH agar) plates were employed and divided into two groups of 10 plates each. In all the plates three wells were made by removal of agar at equidistant points on each plate. In group 1, 10 plate wells were filled with root canal sealers and in group 2 10 plate wells were filled with root canal sealers after addition of polysorbate 20. After incubation the diameter of zones of Inhibition around the plates were measured and the values will be statistically analyzed using one way ANOVA test.

Results: Endomethasone exhibited highest antibacterial activity before and after addition of polysorbate and there was statistically significant difference in the antibacterial activity of each root canal sealers ($p<0.05$) after the addition of polysorbate. There was no statistically significant difference among different sealers in their antibacterial activity.

Conclusion: Based on the results of this study antibacterial effect of root canal sealers improved after addition of the surfactant, polysorbate.

Keywords: Polysorbate, Endomethasone, Apexit Plus, AH plus, Antibacterial

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Introduction

Microorganisms are the main etiological factor in pulpitis and apical periodontitis. Instrumentation, irrigation and endodontic medications are the means to achieve their removal. Nevertheless the complexity of internal anatomy of the tooth, particularly at the apical thirds of root canals makes the complete removal of microorganisms a difficult task. Sometimes microorganism's persistence and reproduction in these areas may even results in complete failure of the treatment particularly in the long run.[1] The presence of microbes at the time of obturation can significantly reduce the success rate of endodontic therapy.[2]

Over the past years it was thought that root canal sealers played a secondary role by simply cementing the filling material into the canal. Presently, it is appreciated that the sealers have a primary role in sealing the canals by obliterating the irregularities between the canal wall and the core material. Improvement of the overall success rate of endodontic treatment is achieved by sealing material that exhibit both excellent sealing and antibacterial property.[3]

The sealing ability is improved by the addition of surfactant. Polysorbate is a non-ionic surfactant which is used as an emulsifying agent, solubilizing agent and wetting agent in various pharmaceutical preparations, cosmetics and food products.[4] Polysorbate 20NF is a surfactant and emulsifier that is common ingredient in dental products such as tooth whiteners and mouthwashes. The antimicrobial activities of paraben preservatives have been reduced in presence of polysorbate. It has been recognized that some essential oils have different antimicrobial activities against individual strains of microorganisms.[5]

The aim of this study is to compare the antimicrobial efficacy of the three root canal sealers namely; zinc oxide eugenol based sealer (Endomethasone), calcium hydroxide based sealer (Apexit plus) and resin based sealer (AH Plus)) before and after the addition of polysorbate 20 against *Enterococcus faecalis* using agar diffusion test.

Materials and methods

The study was carried out using three root canal sealers namely Endomethasone, AH Plus, and Apexit Plus (Table 1). Standard strains of Enterococcus faecalis MTCC 439 was used in this study. All sealers were tested using the ADT with and without addition of polysorbate 20.

Enterococcus faecalis was tested on Mueller-Hinton (MH) agar. Inocula from a 24 hour growth of the test organisms were added in sterile saline, incubated at 37ºC and allowed to grow to obtain a turbidity equivalent to the 0.5 McFarland standards (approximately 3×10 C˚cells/mL). Aliquots of the suspension containing *E. faecalis* were spread on *140*- mm diameter petri dishes containing MH Agar (MHA) medium. A sterile cotton swab was used to evenly streak the test organisms on the agar plates.

Twenty MHA plates were divided into two groups each. Three wells of 10mm diameter were punched in each agar plate equidistant from each other. Three wells in each 10 MHA plates were filled with three root canal sealers mixed according to the manufactures instruction. Remaining 10 MHA plates were filled with sealers and polysorbate mix which were prepared by addition of one drop of polysorbate with the help of a micro pipette to the sealers mix. The properties of polysorbate is mentioned below(Table2).

The plates were maintained at room temperature for two hours per diffusion of the material and then incubated at 37°C for 24 hours. After incubation the diameter of zones of inhibition around the wells in each plates were measured and recorded. It was done by a calibrated ruler from one end of the inhibition zone passing through the centre of the well. The average reading with a standard deviation was calculated for each

sealer tested. The sealer which exhibited the largest zone of inhibition was considered as having the most efficient antimicrobial activity (Fig 1).

Table 1: Composition of the root canal sealers used in the present study

Sealers	Composition
Apexit Plus	Base: Calcium hydroxide, Hydrogenised colophony, silicon dioxide, zinc oxide, calciumphosphate, polydimethylsiloxane, alkyl ester of phosphoric acid Activator: Trimethylhexanedioldisalicylate, bismuth carbonate, bismuth oxide, silicon dioxide,butanedioldisalicylate, hydrogenised colophony,calciumphosphate, alkyl ester of phosphoric acid
Endomethasone	Hydrocortisone acetate, Thymol iodide, barium sulphate, zinc oxide, magnesium stearate
AH Plus	Diepoxide, Calcium tungstate, zirconium oxide,Aerosil, Pigment 1-adamantine amine, N,N'-dibenzyl-5-Oxa-nonadiamine-1,9 TCD-Diamine, zirconium oxide,Aerosil and silicicone oil

Table 2: Properties of polysorbate 20 (Tween 20)

Properties of polysorbate 20 (Tween 20)	
Appearance	Clear, yellow to yellow-green viscous liquid
Boiling point	>1001°C
Brookfield Viscosity	370-430 cps (25 °C, neat)
pH of 1% aqueous solution	5-7
Specific gravity	1.1
HLB (hydrophile-lipophile balance) value	16.72
CMC value	60 mg/l

Table 3: Results showing diametre of zone of inhibition in mm, comparing the sealers before and after addition of surfactant

Sealer	Group 1 (Mean ±SD)	Group 2 (Mean ±SD)	p value
AH Plus	18.5±0.93	24 ± 0.97	0.046*
Endomethasone	18.8±1.7	31 ± 2.51	0.026*
Apexit Plus	17 ±1	28.33 ± 0.95	0.018*

p value <0.05 = significant

Statistical analysis

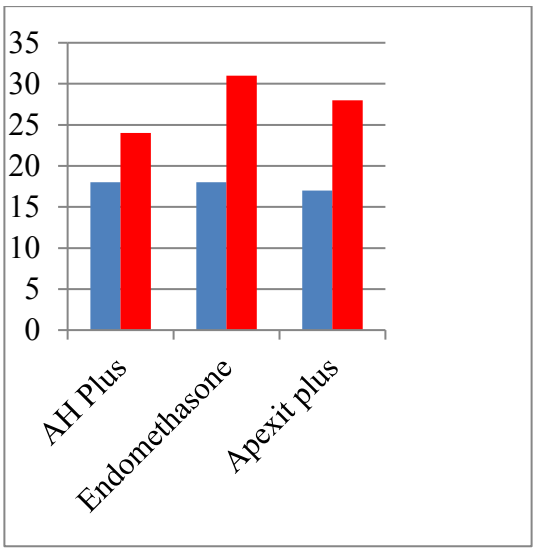
Descriptive statistics including mean, standard deviation of each sealer was analyzed. Interval statistics including one-way analysis of variance (ANOVA) was conducted to test statistically significant difference between the sealers antibacterial effect after addition of polysorbate with the help of SPSS 17 version software. p value <0.05 was set to be statistically significant.

Results

In group 1, the highest mean inhibition zone produced against *Enterococcus faecalis* was exhibited by Endomethasone followed by AH plus and Apexit plus sealers respectively, but there was no statistically significant difference among different sealers in their antibacterial activity (Table3).

Fig 1 : zone of inhibition exhibited by the root canal sealers

Table 4: Comparison of antimicrobial efficacy of root canal sealers after addition of polysorbate



Red : Group 1
Blue : Group 2

In group 2, the highest mean of inhibition zone produced after addition of polysorbate 20 was exhibited by Endomethasone, followed by Apexit Plus and AH plus respectively. There was a statistically significant difference for each sealer in their antibacterial activity after the addition of polysorbate 20 (Fig 2).

Discussion

The objectives of modern root canal therapy are to clean and shape the root canal system, removal of all organic material, and to seal this system with a permanent filling. To achieve this, it is believed that the root canal filling must seal the pulpal space both apically and laterally to prevent further apical irritation from incomplete elimination of bacterial products and from communication between the apical tissues and the oral cavity.[6] At one time it was thought that sealer played a secondary role by simply cementing the core filling material into the canal. All modern obturating techniques make use of sealer to enhance a fluid tight seal of the pulp space.

For a number of years, the addition of an antimicrobial agent to root canal cement had been the subject of controversy among some members of the dental profession. Those who have advocated the use of an antimicrobial agent thought that it would help to sterilize or to maintain root canal in a sterile state. Those who opposed the addition claimed that for an antibacterial agent to be effective it must be soluble, and in that case the seal of the canal would be compromised, leaving the canal susceptible

to reinfection.[7] Grossman advocated that the ideal root canal filling material should be bacteriostatic. Geurtsen and Leyhausen proposed that the ideal root canal sealer must have both good antimicrobial activity and low toxic effects on surrounding tissue.

Sealing ability is improved by addition of a surfactant and by increasing the wetting property. Surfactants are compounds that lower the surface tension between two liquids or between a liquid and a solid. Polysorbates are class of emulsifiers used in some pharmaceuticals and food preparations. They are often used in cosmetics to convert essential oils into soluble water-based products. They are perhaps one of the most commonly used nonionic surfactants, since they are sugar-based surfactant and considered as the safest surfactant.[8]

Polysorbates are polyoxyethylene sorbitan fatty acid esters available with different formulations as polysorbate 20,21, 40,60, 61, 65 and 80 based on their change in the fatty acid group. TWEEN 20 is the commercially available name of polysorbate 20 which is chemically polyoxyethylene sorbitan monolaurate. TWEEN 20 is a nonionic detergent and frequently used member of the polysorbate family. These have been used as emulsifying agents for the preparation of stable oil-in water emulsions.[9]

It is proposed that polysorbate showed no antibacterial effect of its own but it produced a potentiative effect. Polysorbate is among the many drugs directly or indirectly influencing cell membrane properties; for example, the interactions between proteins and phospholipids or the formation of complexes between ligand molecules and phospholipids which can lead to disruption of the membrane so that, it becomes highly permeable. Because of the unique structure of a lipoid matrix consisting of phospholipids and embedded proteins, the interaction of surfactant molecules with polar head groups, non polar hydrocarbons, or both, can induce several changes in the membrane.[8, 9] The agar diffusion method has been widely used to test the antimicrobial activity of dental materials and medications. The advantage of this method is that it allows direct comparisons of root canal sealers against the test microorganisms, indicating which sealer has the potential to eliminate bacteria in the local microenvironment of the root canal system.[10] A disadvantage of the agar diffusion test is that the result of this method does not depend only on the toxicity of the material for the particular microorganism, but is also highly influenced by the diffusibility of the material across the medium. A material that diffuses more easily will probably provide larger zones of microbial growth inhibition.[11] Great care was taken to keep the plates for 2 h at room temperature to allow the diffusion of the agents through the agar and then incubated at 37ºC under appropriate gaseous condition.

Endomethasone exhibited highest antibacterial activity before and after

addition of polysorbate(p=0.046). The antibacterial effect of the Endomethasone depends on the activity of their chemical components (Eugenol, Dexamethasone). Eugenol is a chemical essence of oil of clove, it has been used in endodontics primarily as anodyne and also as an antibacterial agent in higher concentration (10^{-2} 10^{-3} mol L).[12] Eugenol is also lipophilic, affecting the lipid in cell membrane and increasing the cell membrane permeability so this may be another mechanism by which eugenol could have antibacterial activity.[13] Dexamethasone which is incorporated in its composition is well tolerated by tissues and it provides anti-inflammatory, antiseptic and germicidal actions. Zinc oxide eugenol based materials, have a strong antibacterial effect due to eugenol release even after setting, which was confirmed by other researchers.[14] Zinc oxide has a small part in this activity whereas eugenol plays the dominant role.

Second highest zone of inhibition is exhibited by Apexit plus after the addition of polysorbate. The antibacterial activity exhibited by Apexit plus and AH plus sealer was comparable before the addition of polysorbate. The antimicrobial effect exerted by Apexit plus is due to the ionic dissociation of the sealer into calcium (Ca^{2+}) and hydroxyl (OH^-) ions leading to an increase in pH to 12.5. At pH greater than 9, the compound reversibly or irreversibly inactivates the microbial cell membrane enzymes, resulting in the loss of biological activity and destruction of the cytoplasmic membrane.[15,16]

Using the ADT, the inefficiency of some calcium hydroxide based sealers might be related to low solubility and diffusivity of these substances in agar. By addition of the polysorbate solubility of Apexit plus is improved.[14]But there was no noticeable change detected in the solubility of AH plus sealer after the addition of polysorbate. Only after the addition of polysorbate, did the antibacterial property have been improved.

Enterococcus spp. usually constitute a small proportion of the initial flora in the untreated root canal, this genus is 40% in primary endodontic infection and 70% in persistent endodontic infection.[17,18] The selected strain MTCC 439 also exhibit the experimental quality as required for the study.

Conclusion

The results of this study showed statistically significant difference in their antibacterial activity after the addition of polysorbate 20. Endomethasone sealer exhibited the largest zones of inhibition. It was found to be superior to AH plus and Apexit plus in inhibiting the microorganism. However, it should be taken into considerations that the data presented here relate to in vitro conditions, and in vivo conditions such as the presence of dentin and serum might modify the antimicrobial efficacy of sealers. Hence, further in vivo studies are needed to evaluate the antimicrobial efficacy of sealers after the addition of polysorbate.

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PIEZOELECTRIC SURGERY: A BOON TO IMPLANTOLOGY

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****Dr. Swapna.C, ****Dr. Sheejith.M, *****Dr. Ranjith.M

Abstract

The use of ultrasonic vibrations for the cutting of bone was first introduced two decades ago. Piezoelectric surgery is a minimally invasive technique that lessens the risk of damage to surrounding soft tissues and important structures such as nerves, vessels, and mucosa. It also reduces damage to osteocytes and permits good survival of bony cells during harvesting of bone. In addition, piezoelectric surgery produces less vibration and noise because it uses microvibration, in contrast to the macrovibration and extreme noise that occur with a surgical saw or bur. This article reviews the wide range of application of piezoelectric technique in implantology.

Keywords: Piezoelectric surgery, sinus lifting, ultrasonic device, implant, piezosurgery

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Introduction

The success of any treatment modality in dentistry depends upon the tools by which the treatment is being carried out. Hard tissue cutting tools such as micromotor handpiece, and airotor remove enamel, dentin, cementum as well as bone. The amount and quality of hard tissue removal determines the post- operative outcome of any dental surgical procedure, be it implantology or periodontology.[1]

Conventional methods of harvesting bone for grafting frequently require the practitioner to use rotary instruments close to blood vessels or nerves, which involves risk of section or avulsion with potential haemorrhage or nerve damage. Using this type of traditional instrumentation is inappropriate as the rotation rate is difficult to control when a motor or turbine is used and space requirements may pose risk to surrounding tissues. Moreover, management of post-operative complications (haematoma, oedema or pain) has frequently been proved as an obstacle for practitioners with little training in this type of surgery.[2]

To overcome the limitations of traditional tools, researchers have come up with advanced therapeutic devices which use the principle of ultrasonic microvibrations to make precise and selective cut on the bone in harmony with the surrounding tissues.[1,3] One of the novel methods to 2 incorporate these properties of ultrasonics is piezosurgery. This is a relatively new alternative for bone-related procedures introduced in the field of dentistry. It has a wide potential for usage with the devices running according to the piezoelectric principles and capable of cutting by way of ultrasonic vibration.[3,4] These vibrations are low frequency modulated vibrations at 25 to 30 KHz which selectively cut the bone without damaging adjacent soft tissues in particular with delicate structures such as schneiderian membrane or a nerve.[4]

Historical background

The term "piezo" originated from the Greek word piezein, and means "to press tight, squeeze".[5] French Physicists Jean and Marie Curie first mentioned the direct Piezo-Effect in 1880, whereby certain crystals produce electrical current while under mechanical pressure. The reciprocal effect, by which the crystals are deformed when under electrical current, was then discovered a while later. This is the effect being used by the piezosurgey Device in which the electrical field is located in the handle of the saw. Due to the deformation caused by the electrical current, a cutting – hammering movement is produced at the tip of the instrument.[6]

Mectron produced the first prototype device for piezoelectric bone surgery with which the first extraction treatments were performed. In 1999 Tomaso Vercellotti introduced the name PIEZOSURGERY® for the new method. Mectron also developed 2nd generation of the piezosurgery device in 2004 which was more powerful than the previous device. In the year 2009 3rd generation piezosurgery device was introduced (Fig-1). Currently piezosurgery is very commonly and successfully used in implant dentistry.[1]

Fig 1: The Equipment
(Courtesy: Mectron Dental- India Pvt Ltd)

Mechanism of action of piezoelectric devices

Piezosurgery works on the principle of 'Pressure Electrification.[3] Materials used here are piezoelectrical crystals which generally include quartz, Rochelle salt and certain types of ceramic. When these crystals are subjected to an electrical charge, they expand and contract alternately to produce ultrasonic waves. Since these ultrasonic waves are mechanical in nature, they can induce disorganization and fragmentation of different bodies. The ultrasonic waves can allow segmentation of interfaces from solid to solid by means of distinct vibration, and solid-liquid by cavitation. In dentistry these two phenomena are used.[3,4]

The bone-cutting technique of the piezoelectric device works due to the use of microvibrations at a specific ultrasonic frequency modulated by sonic waves. The sonic and ultrasonic frequency (25–30 KHz) is produced by a mechanical shock wave that vibrates in a linear manner. The cutting tip works with reduced vibration amplitude (horizontal 20–200 µm, vertical 20–60 µm). This allows for the main advantages of this device, which are precise and selective cutting, the avoidance of thermal damage, and safety for the patient. At this amplitude, only mineralized tissue will be cut, because soft tissue requires frequencies of greater than 50 KHz. Therefore, its use will reduce the risk of nerve damage. The reduction of overheating is explained by the generation of a cavitation effect in the irrigation solution due to the mechanical micromovements at its frequency. This also accounts for reduced bleeding.[7]

Bone that has been harvested with a round bur on low and high speed hand-pieces, a spiral implant bur, or safe scrapers, is not suitable for grafting because of the absence of osteocytes and the predominance of non-vital bone. Recently, Stubinger et al showed that autologous bone from the zygomaticomaxillary region that had been harvested with a piezoelectric device could be used in augmentation for stable and aesthetic placements of oral implants after a 5-month's healing.[8]

In another histomorphological study, porous titanium implants were inserted into minipig tibias. The concentration of Bone Morphogenetic Protein (BMP)-4; Transforming Growth Factor (TGF)-β 2; tumour necrosis factor α; and interleukin-1β were evaluated in peri-implant osseous samples. The analyses showed that neo-osteogenesis was consistently more active in bony samples from implant. [4] Sites that had been prepared using piezoelectric surgery, and there was an earlier increase in BMP-4 and TGF-β 2 proteins, and fewer pro-inflammatory cytokines in bone around the implants.[9]

Application of piezoelectric surgery in implantology

Piezosurgery has extensive applications in dental implantology. It can be used in hard tissue procedures, such as implant site preparation, ridge split, bone grafting, and in soft tissue procedures such as maxillary sinus lifting, and lateralization of inferior alveolar nerve.[7,10]

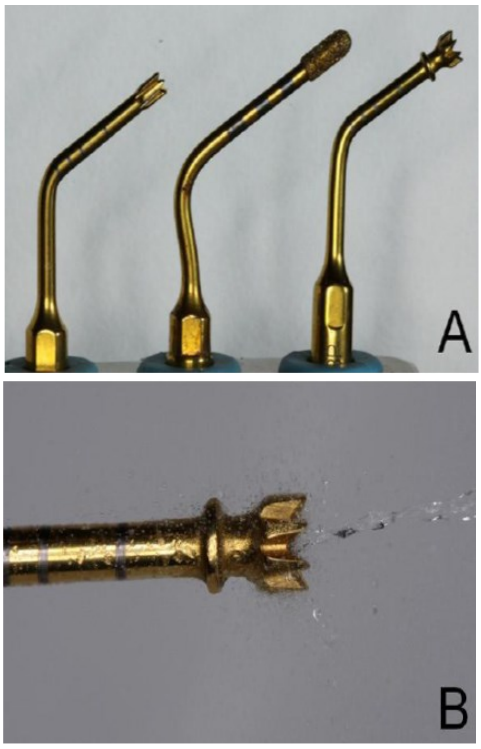

Fig2: Implant site preparation can be performed with a specifically designed set of piezosurgery inserts in lieu of conventional drills (A). An internal serum flow canal inside the inserts ensures constant irrigation and cooling of the bone during the preparations (B).

Preparation of implant site

As a new technique, implant site preparation can be performed with a specifically designed set of piezosurgery inserts (Fig 2). Piezosurgical site preparation allows for the selective enlargement of only one socket wall. This is called 'differential ultrasonic socket preparation' by Vercellotti.[10]

Piezosurgical site preparation provides a similar primary stability and short-term survival rate of an implant when compared with conventional site-preparation techniques. Stelzle et al. emphasized that the applied load on the handpiece may increase the preparation speed but may also increase the negative thermal effect on the bone.[11]

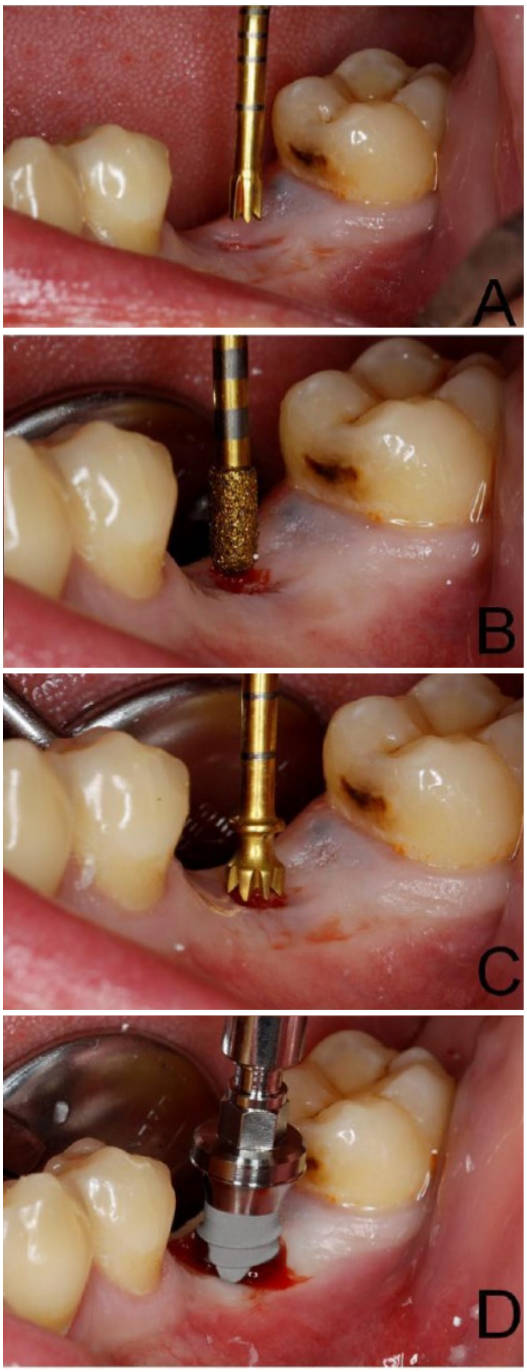

Fig 3: Basic preparation sequences of piezosurgical implant site. Cutting insert with a 2-mm diameter used for pilot osteotomy (A); cylindrical diamond-coated insert with 2.4-mm diameter used for differential preparation (B); cutting insert with 3-mm diameter used for final preparation (C) and an implant being inserted (D). There is still a need of using the final drill of the selected implant system in order to tightly accommodate the implant into its socket.

Therefore, it is recommended that a maximum load of 400 g is used during implant site preparation (Fig 3). Resonance-frequency analysis was used to evaluate the implant-stability quotient in sites prepared by either conventional drilling or piezoelectric tips, showing significant increases in quotient values for the piezosurgery group.[7]

Edentulous ridge splitting

In insufficient width of the alveolar ridge, the edentulous ridge-splitting technique can be applied. For this procedure, the lingual plate is separated from the buccal plate of the edentulous ridge (Fig 4). One of the major advantages of edentulous ridge splitting is the avoidance of donor-site morbidity, because no graft is needed. When the thickness of the ridge is reduced to about 4 mm in the most coronal position and the volume increases in the apical direction, preparation of the implant site with burs produces a dehiscence that is generally vestibular and leads to the exposure of several millimeters of the thread of the implant. When atrophy is more severe and the ridge is less than 4mm and it does not present an apical expansion, the standard method with burs must be abandoned because its use will bring about the complete destruction of the residual crestal bone. It has been stated that the traditional mechanical expansion methods cannot be used with predictable outcome in the presence of a mineralized bone ridge as is often seen in a long-standing edentulous zone.

The basis of the new piezoelectric ridge expansion technique is the use of

variable frequency piezoelectric energy as a powerful and efficacious surgical force that is able to cut bone without uncontrollable traumas. This permits the expansion of the edentulous ridge, no matter what the quality of the bone, even in the case of the most mineralized. The ridge splitting of the mandible can raise complications due to the inferior alveolar nerve, particularly if a significant amount of bone is lost. Furthermore, the risk of fracturing the bone segments in the cortical mandible is an issue. However, with the use of a piezoelectric device with bland tips, the ridge splitting procedure is very safe even if the inferior alveolar nerve is touched.[7,12]

Bone grafting

Dental implants are possible only if sufficient residual bone volume is available. Different techniques for ridge augmentation have been published and proven to be very sufficient. Autogenous bone grafts from the chin or the ramus are the most common choices if only a limited amount of bone is needed. For larger bone volumes, other donor sites such as the iliac crest have to be considered. Mouraret et al compared the piezoelectric device with a conventional bur in an in vivo mouse model. Osteotomies performed with the piezoelectric device revealed greater osteocyte viability and reduced cell death, while bone grafts exhibited better cell viability, new bone deposition, and bone remodeling.[13]

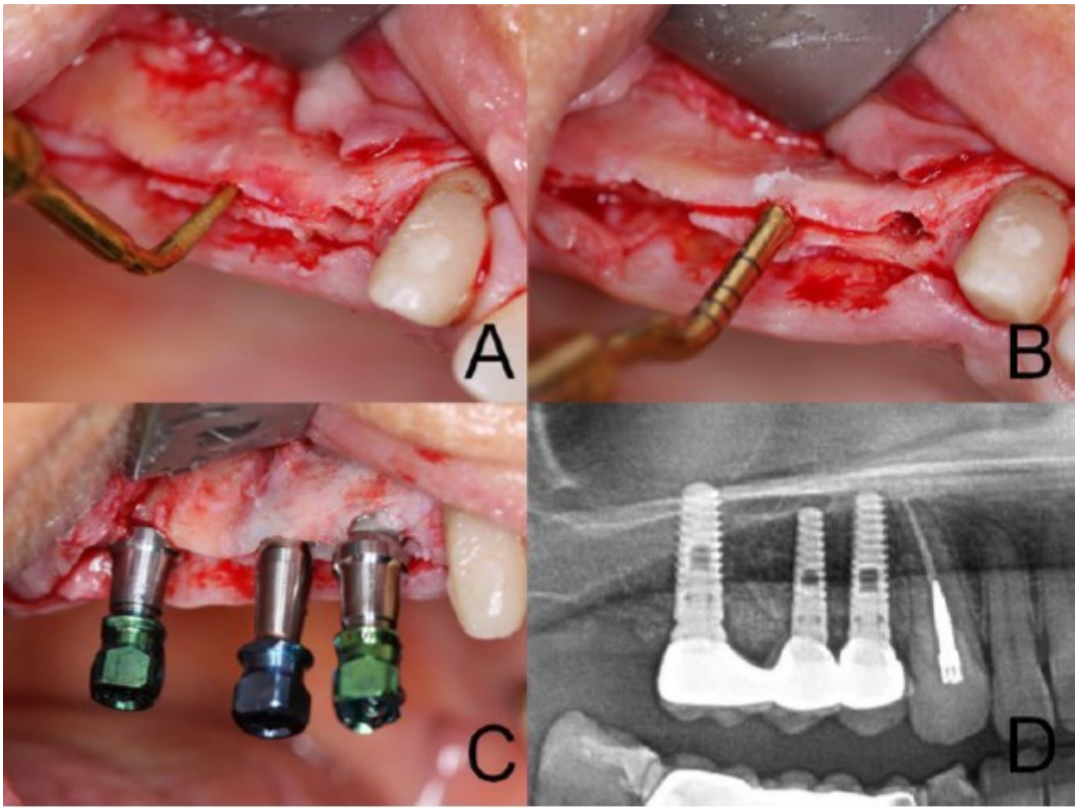

Figure 4: Alveolar crest with horizontal bone deficiency can be split and expanded successfully using a thin saw-shaped piezosurgery insert for immediate implant placement (A and B). A maxillary ridge split that follows immediate placement of three implants with good primary stability (C). Panoramic radiograph shows no bone resorption after 3 years of loading of the implants (D).

Piezosurgery requires much less hand pressure than tradi-tional rotary instruments and precise shape of the graft can be obtained from the donor site, thus reducing the morbidity.7 Further if graft is removed with a conventional bur or saw, hammer and chisel has to be used to remove the graft which can increase the risk of damaging teeth roots and soft-tissue structures.

The ultrasound unit gives the possibility to collect autologous grafts in the form of monocortical blocks or bone chips. Bone chips as big as 500 µm are the basis of osteoconductive bone regeneration. The piezo unit enables one to gently scrub the bone surface to gain the right amount of graft material. As far as bone blocks are concerned, the donor beds could be situated in the chin, oblique line of the mandible or iliac crest. Using this technique the easiness of the surgical procedure as well as smaller entrance site are guaranteed (Fig 5).[14]

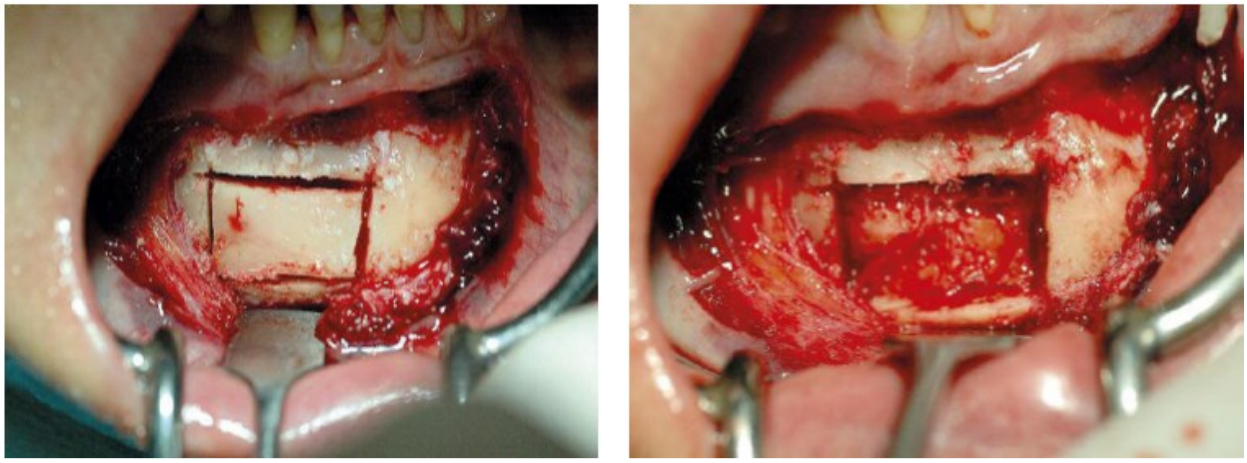

Fig 5: Harvesting of the chin graft

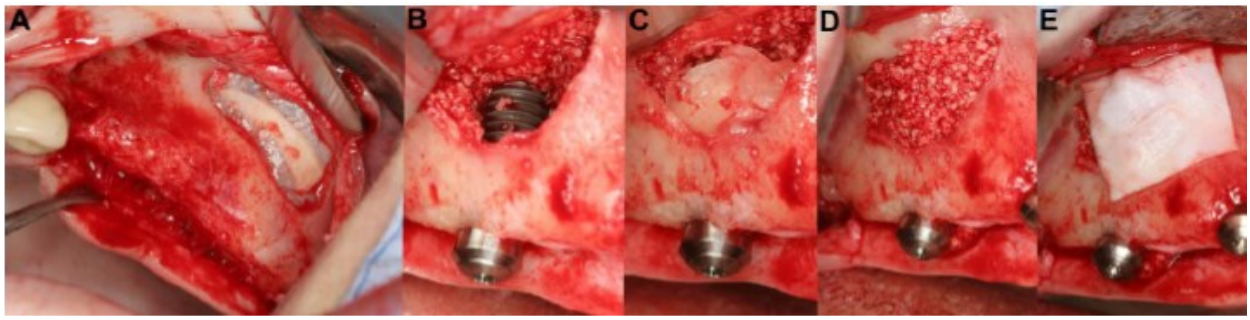

Fig 6: Sinus floor elevation

Notes: Removal of the vestibular alveolar wall (**A**), elevation of the Schneiderian membrane and dental implant placement (**B**). The sinus cavity was filled with bone substitutes and bone chips. Use of the buccal bone for additional stabilization and protection (**C** and **D**). The complete area was finally covered with a collagen membrane (**E**).

Sinus-floor elevation

In edentulous patients with insufficient bone volume and therefore reduced height of the alveolar crest, a sinus-floor elevation is often the most suitable solution to prepare a sufficient donor site for implant insertion (Fig 6).[7] The most common complication of traditional sinus lift membrane technique is the great risk of perforating the Schneider membrane. It can occur either while separating the sinus membrane or while preparing the window and performing the ostectomy using the surgical round bur at low speed.[14]

The surgical procedure includes the removal of a bony window of the anterior sinus maxillary wall. A precise cutting device that does not perforate the Schneiderian membrane is preferable to conventional methods. If a perforation occurs and bone grafting is completed, there is a risk for an inflammatory complication, which can necessitate further surgical procedures.15 Seoane et al demonstrated in his study that the use of the piezoelectric device reduces the frequency of membrane perforation among surgeons with limited experience. Specific tips can even decrease the risk of accidental or iatrogenic perforations.[16] Vercellotti et al presented a surgical protocol using piezoelectric surgery where a clear reduction (5%) of membrane perforation could be achieved. In comparison, the prevalence with rotary instrumentation varies between 5% and 56%.[17]

Lateralization of the inferior alveolar nerve

The first account about inferior alveolar nerve repositioning was published in 1977 by Alling in the context of prosthetic rehabilitation of patients with severe atrophy and emergence of the mental nerve close to the alveolar crest.[18] In 1987, Jensen and Nock described the first inferior alveolar nerve transposition in conjunction with dental implant surgery.[19] The lateralisation of the inferior alveolar nerve offers the following main advantages:

1. Implants of greater length can be inserted.
2. No bone grafting is required.

However, nerve repositioning is a complex procedure, with a high risk of sensory disturbances.20 According to Bovi, piezoelectric surgery can simplify this procedure, due to the lack of soft tissue trauma and the particular inserts inclinations. Bone drills and oscillating saws represent more aggressive cutting instruments which are relatively difficult to control (e.g. due to the generation of macrovibrations), and which are more damaging to soft tissues. Compared with these traditional cutting instruments the main disadvantage of piezosurgery concerns the increase in the operating time. Touching the inferior alveolar nerve with piezoelectric inserts results at most in roughening of the epineurium without harming deeper structures, as far as heat injuries are prevented by an appropriate handling of the ultrasonic device.[18]

Conclusion

Piezoelectric devices are an innovative ultrasonic technique for safe and effective osteotomy or osteoplasty compared with traditional hard and soft tissue methods that use rotating instruments because of the absence of macrovibrations, ease of use and control, and safer cutting, particularly in complex anatomical areas.

With respect to current and future minimally invasive and innovative surgical concepts, piezoelectric surgery offers a wide range of new possibilities to perform customized osteotomies for bone reconstruction and placement of smart implants.[7]

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MAP AND APPROPRIATECH IN THE MANAGEMENT OF COMPLETELY EDENTULOUS PATIENTS: A REVIEW

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Abstract

Evidence of oral health quality improvement is more obvious in the restoration of the edentulous mouth since the advent of osseointegration. However, accessibility of this high-cost treatment to the majority of the world's population remains a serious concern. Cost cutting is often achieved by sacrificing or ignoring sound prosthodontic principles. It is ought to set out for each procedure a Minimum Acceptable Protocol (MAP) that will conform to generally accepted prosthodontic principles, and will assist patients in regaining chewing function and esthetic rehabilitation, and thereby significantly improve their quality of life. The aim of this review article is to introduce the concept of MAP (Minimum Acceptable Protocol)and Appropriatech in the management of completely edentulous patients.

Keywords: MAP, Appropriatech, Delphi survey

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Introduction

Prosthodontics offers an extraordinary range of treatment possibilities for oral rehabilitation. However, its reliance on the high-technology end of the spectrum of possibilities inevitably limits it to relatively few people. There is nothing wrong with "high-tech" solutions, for it is the research into such solutions that has provided astonishing advances. But by emphasizing such solutions, health professionals risk usurping their professional mandate.[1]

Partial and complete edentulism are still experienced by millions of people, even in some of the most advanced economies of the world. A high percentage of them do receive prosthesis, yet there are many who do not. Tooth loss per se is not necessarily an indicator of oral or other dysfunction. It is the extent of tooth loss that is related to oral health, and in turn to the quality of life.

Evidence of oral health quality improvement is more obvious in the restoration of the edentulous mouth, particularly since the advent of osseointegration. However, accessibility of this high-cost treatment to the majority of the world's population remains a serious concern. The emerging popularity of the two-implant supported overdenture appears to be an important initiative, but it may remain restricted to the very few high-per-capita-income population. Hopes for its routine prescription are very far removed from the reality of the rest of the world, and therefore from the majority of edentulous patients. To provide treatment for the many, cost-effective conventional treatment is required,

but with adequate quality control. When this is lacking, patients have to adapt to inadequate prosthesis with risks of iatrogenic morbidity. Cost cutting is often achieved by sacrificing or ignoring sound prosthodontic principles. It ought to be possible to set out, for each procedure, a minimum acceptable protocol (MAP) that will conform to generally accepted prosthodontic principles, and will assist patients in regaining chewing function and esthetic rehabilitation, and thereby significantly improving their quality of life.[1]

Given the emerging and profound impact that an evidence-based approach has had on clinical practice, it is now opportune to introduce the philosophy of *appropriatech:* that uses appropriate technology (both methods and materials) to provide cost-effective treatment without sacrificing biofunctional and prosthodontic principles.

Minimum Acceptable Protocol (MAP)

- A series of principles that should, at the very least, be followed for any given treatment modality can be gathered into a Minimum Acceptable Protocol.
- MAP offers an inclusive and comprehensive alternative to the therapeutic restrictions inherent in many standards of care. It offers selection of treatments complying with the principles and from which an appropriate treatment can be selected to suit the resources available and preferences of the patient.
- MAP offers the possibility of maximizing the outlay of resources for the least advantaged in society.
- MAP brings all the evidence together into a set of guidelines and pathways to identify the most appropriate and timely intervention for a particular patient.

MAP in Complete Dentures

This concept arose from the need for some consensus on the prosthodontic principles to be followed when constructing complete dentures. A continuum of care based on the MAP brings all evidence together into a set of guidelines and pathways to identify the most appropriately and timely intervention for a particular patient. A Delphi survey was conducted for the purpose of obtaining consensus on prosthodontic principles to be followed when constructing complete dentures.[2] It seemed an ideal method to develop consensus on MAP for complete dentures, and the International College of Prosthodontists (ICP) provided a readily identifiable worldwide panel of experts. Respondents could also provide comments on any aspect of the questionnaire. The statements were then modified in the light of the responses and comments received, and recirculated. Three rounds of questionnaires were used, and only statements achieving a 90% or greater consensus were included in the MAP. The respondents were randomly selected from the 2004 membership e-mail list of the International College of Prosthodontists.

Forty-one respondents answered the first questionnaire, 39 the second, and 36 the third. The 75 statements in the first questionnaire were gradually reduced as consensus was reached, and eventually 18 statements remained with 90% or greater agreement. MAP could now be used to help

assess clinical techniques that attempt to reduce time and costs while producing a quality service in other words, which will conform to the philosophy of appropriatech.[2]

Guidelines of MAP for the construction of Complete Dentures:

Initial Preparatory Phase

- The patient's specific goals regarding expectations of comfort, function, and esthetics should be recorded prior to treatment.
- The patient's experience, if any, with complete dentures and his or her self-assessment of any existing prosthesis should be recorded prior to treatment.
- It is preferable to ensure a healthy mucosa prior to making final impressions.
- Healthy mucosa usually may be achieved with a combination of methods, such as the use of tissue conditioners, leaving the dentures out prior to impression making, and adjustment of the existing dentures.
- If any candidal infection is diagnosed and recorded, this preferably should be treated prior to impression making.

Treatment Phase

- The final impression can be made in a material, supported in a variety of ways, which will allow the operator to achieve optimum conformity to the requirements of appropriate coverage, intimate tissue contact, and border (peripheral) seal.
- The center line for the maxillary anterior teeth and the occlusal plane should be determined by the operator, and this information transferred by setting some teeth and/or marking and adjusting an occlusalrim.
- A recognized method should be used to record the centric relation position at the desired vertical dimension of occlusion, such as interocclusal recording method, or by means of intraoral tracing.
- The vertical dimension of occlusion should allow for an interocclusal (freeway) space. The amount of this space should be sufficient for function, speech and esthetics, and be appropriate to each patient.
- The arrangement of the anterior teeth should show evidence that the technician and clinician have taken into account a variety of factors to reconcile appearance with function, such as soft tissue profiles, phonetics, occlusal plane orientation, neutrality, and that the appearance is appropriate for that specific patient.
- The patient should be part of the decision-making process for the appearance of the teeth, guided by the clinician.
- The arch form should show that the clinician has arranged the teeth in a neutral position in the available denture space and should contribute to stability in function.
- The occlusal scheme should be clearly capable of contributing to the stability of the dentures when in function.
- There should be even contact on all posterior teeth in the intercuspal position (centric occlusion), which should enable the patient to return to this position during function without causing instability of the

denture or disharmony with the muscles and joints.

- The occlusion should be finally adjusted according to observations made after processing.
- Attempts should be made to identify any possible border/peripheral overextensions and/or fitting surface discrepancies, either by observation or by the use of appropriate materials.
- The patient should receive instructions on proper hygiene and the need for future visits.

Post treatment Phase

- At recall, the mucosa should be checked, even if there are no complaints.
- When assessing complete dentures for the need to make adjustments or to determine the need for replacement, the clinician should assess loss of vertical dimension, stability, retention, the patient's reported ability to chew to his or her satisfaction, and the patient's satisfaction with his or her appearance.[3]

Appropriatech

"Appropriatech" is a term coined from the expression "appropriate technology" and is used here to denote the use of cost effective materials and methods without sacrificing any of the accepted principles of care.[4,5] It offers the possibility of clinical techniques based on time-honoured principles of prosthodontics that provide cost effective and useful treatments to meet the biological, social, financial, and psychological circumstances of a particular patient at a particular time. It is mainly applicable in developing countries, but the concept finds application in any community where cost and time savings are beneficial.

Conclusion

The issue of what standard of care we mean has become a kind of Garden of Good and Evil. MAP is most definitely a good boon. Many in this world are poor and have as much right to a high standard of treatment as those who are rich. That standard can be maintained within a set of agreed-upon principles and can be applied in a more cost-effective manner. For example, it is possible to construct a set of mucosa-borne complete dentures in a few visits using inexpensive materials and techniques. The current world economic order has shown itself to be no better at eradicating poverty than any previous system. The fact is that in this world, many are poor, deprived especially in terms of education, and their health suffers. In oral health this is manifested by succumbing to dental diseases and tooth loss. Modern prosthodontics can affect the most wonderful solutions through oral rehabilitation, but we are in danger of letting our advanced technology block out our vision of our humanistic priorities. The International Prosthodontic Community should provide guidance into ways and means of helping the disadvantaged achieve an improved quality of life. This is a compelling challenge for our profession, particularly for prosthodontics, and both national and international specialist constituencies need to accept it.

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BIOLOGIC WIDTH IN RESTORATIVE DENTISTRY

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Abstract
Maintenance of the gingival health constitutes one of the keys to the longevity of tooth and dental restorations. Biologic width is the physiologic dimension of the junctional epithelium and connective tissue attachment located between the base of the sulcus and alveolar bone crest. Similar to this feature of dentogingival junction, a constant dimension of soft tissue attachment must be present around implants. Violation of biologic width leads to complications like gingival inflammation and alveolar bone loss. Many clinicians have been unable to apply the concept of biologic width practically. Hence the purpose of this article is to describe the biologic width anatomy, evaluation and correction of its violation by different methods.

Keywords: biologic width, junctional epithelium, gingival inflammation, bone loss.
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Introduction

Biologic width is the term applied to the dimensional width of the dentogingival junction. It was first described by Sicher in 1959 as "dentogingival junction" to which he referred as "physiologic division of labor of supporting tissues".[1] Biologic width is of great significance with respect to restorative dentistry as it provides a natural seal that develops around teeth and dental implant, protecting the alveolar bone from infection and disease.[2] Biologic width represents anatomic and physiologic tissues where the host responds to physical (e.g., restorative margin, abutment and microgaps) and environmental (e.g., bacteria and chemicals) challenges through the initiation of inflammation and tissue changes. The restorative dentist needs to take into account that these are responsive biologic tissues and that impingement of these has consequences.[3] Functional and esthetic restoration can be achieved when these restorations maintain harmonious relationship with surrounding structures. Thorough examination before any restorative procedure and proper treatment planning will preserve biologic width and improve the prognosis of restorations with healthy periodontium.[3] Variability exist in this dimensions just the same as mean weight of a man or woman.[4]

Normal Gingival Architecture

Garguilo etal in 1961 reported a certain uniformity of the dimension of some components of biologic width.[5]

a) Mean depth of the histologic sulcus is 0.69 mm

b) Mean junctional epithelium measures 0.97 mm (0.71-1.35 mm)
c) Mean supra alveolar connective tissue attachment is 1.07mm (1.06-1.08 mm)

The sum total of the measured components is approximately 2.04 mm (1.77 to 2.43mm) which is the dimension of a normal biologic width, essential for preservation of periodontal health (Fig1). This dimension from the bottom of the junctional epithelium to the tip of the alveolar bone is held responsible for the lack of inflammation and bone resorption, and the development of periodontitis. The dimension of biologic width is not constant, it depends on the location of the tooth in the alveoli, varies from tooth to tooth and also from various aspect of the tooth.[2]

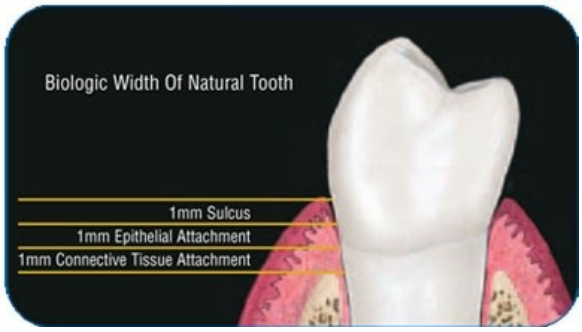

Fig 1: Biologic width around natural tooth

Biologic Width and Dental Implants

The implant epithelium junction (Fig2) is similar to that in the natural dentition, except that it is shorter and thinner than the tooth epithelium junction. Due to the absence of a cementum layer around an implant, most connective-tissue fibers in supracrestal region are oriented in a direction parallel to the implant surface. The average biologic width around implants is 3.08mm which can have significant influence on the characteristics that include implant design, presence of adjacent teeth, and quality of soft tissue.[3] Berglundh and Lindhe (1996) suggested that the soft tissue attachments (biologic width), once established, were nature's mechanism for protecting the zone of osseointegration from the bacterial and mechanical challenges of the oral cavity.[6]

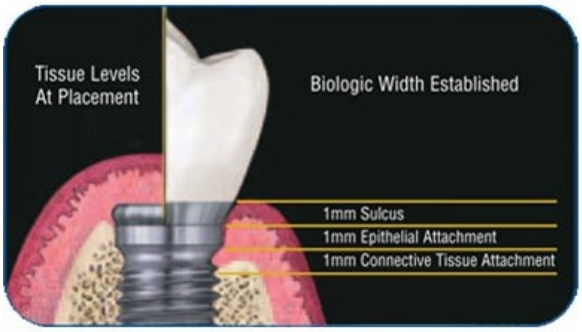

Fig 2: Biologic width around implants

Significance of Biologic Width

Subgingival location of restorative margin invades the attachment apparatus. Orkin et al (1987) demonstrated that subgingival restorations had greater chance of bleeding and exhibiting gingival recession than supragingival restoration. Silness (1980) evaluated the periodontal condition of the lingual surfaces of 385 fixed partial denture abutment teeth. It was found that a supragingival position of the crown margin was the most favorable, whereas margin below the gingival margin significantly compromised gingival health.[7] Teeth with subgingival restorations with narrow zones of keratinized gingiva showed significantly higher gingival index scores than those with wider zones of keratinized gingiva. Thus clinicians should consider gingival augmentation for teeth with minimal keratinized zone before placing subgingival restoration.[8]

Evaluation of biologic width violation

If the patient experiences tissue discomfort when the restoration margin levels are assessed with a periodontal probe, it is a good indication that the margin extends into the attachment and that the biologic width is violated.

***Clinical method*:** The signs of biologic width violation are chronic progressive gingival inflammation around the restoration, bleeding on probing, localized gingival hyperplasia with minimal bone loss, gingival recession, pocket formation, clinical attachment loss, and alveolar bone loss.

***Bone sounding*:** The biologic width can be assessed by probing under local anesthesia to the bone level (Fig 3) and if this distance is less than 2 mm at one or more locations, a diagnosis of biologic width violation can be confirmed. However, this method is not routinely used for biologic width assessment when other methods are available. Its use should be limited to surgical procedures under local anesthesia as a presumptive guide for bone level assessment.

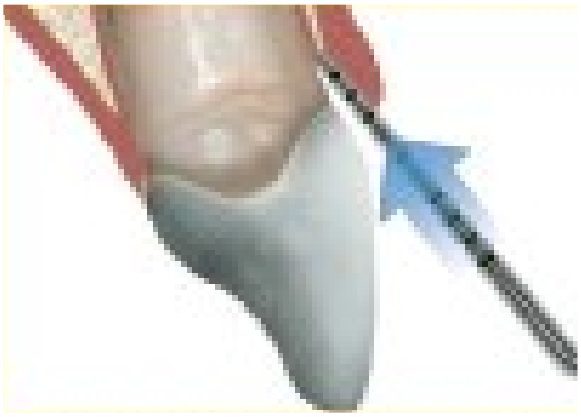

Fig 3: Bone sounding

Radiographic evaluation: Radiographic interpretation can identify interproximal violations of biologic width. A new innovative parallel profile radiographic (PRR) technique has been devised which could be used to measure both length and thickness of the dentogingival unit with accuracy.[3]

Categories of Biologic Width

Kois described three categories of biologic width based on the measurements obtained. They are Normal crest, High Crest and Low Crest.[8]

Normal crest

The mid facial measurement is 3mm and proximal measurement ranges from 3mm to 4.5mm (Fig4A). In this category gingival tissue tends to be stable for a long term. The margin of crown should generally be placed no closer than 2.5mm from alveolar bone. Therefore, a crown margin which is placed0.5 mm subgingivally tends to be well tolerated by the gingiva and is stable for a long term in the normal crest patients.

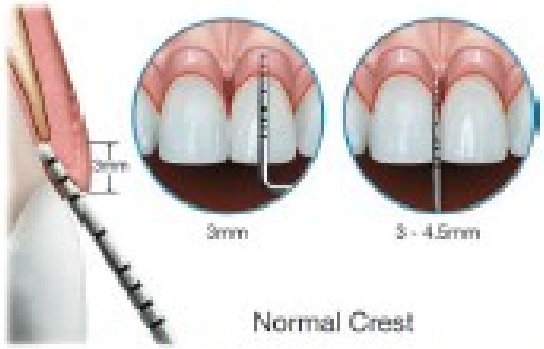

Fig 4A: Normal crest

High crest

In high crest category, both the mid-facial and the proximal measurements are less than 3mm (Fig 4B). In such patients, it is commonly not possible to place an intracrevicular margin because the margin will be too close to the alveolar bone, resulting in a biologic width impingement and chronic inflammation.

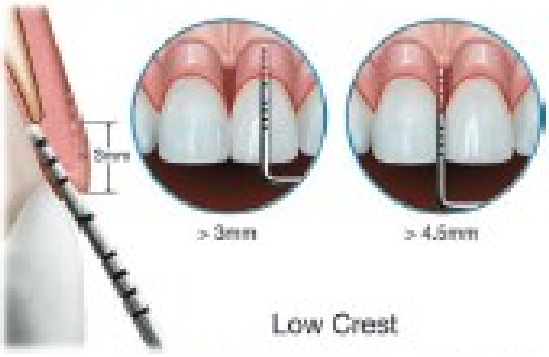

Fig 4B: High crest

Low crest

In low crest category mid-facial measurement is greater than 3mm and the proximal measurement is greater than 4.5mm (Fig4C). Traditionally low crest patients have been described as more susceptible to recession secondary to the placement of an intracrevicular crown margin. When retraction cord is placed subsequent to crown preparation, the attachment apparatus is routinely injured. As the injured attachment heals, it tends to heal back to a normal crest position, resulting in gingival recession.

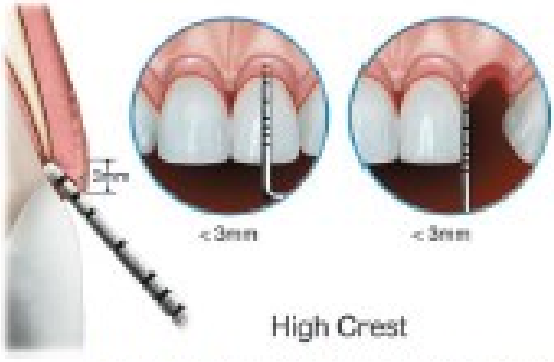

Fig 4C: Low crest

Stable and Unstable Low crest

However, the Low Crest attachment is actually more complex because all of them do not react in a similar fashion to an injury to the attachment. Some are susceptible to gingival recession while others have a quite stable attachment apparatus. The difference is based on the depth of the sulcus, which can have a wide range. Low Crest is divided into Stable Low Crest and Unstable Low Crest. The mid facial attachment when measured, may be similar for both the categories, but the difference lies in the amount of unsupported gingival tissue. In Unstable Low Crest biologic width the amount of unsupported gingival tissue is greater than that of the attachment apparatus and so is not stable, hence susceptible to gingival recession (Fig 5A).

5A

5B

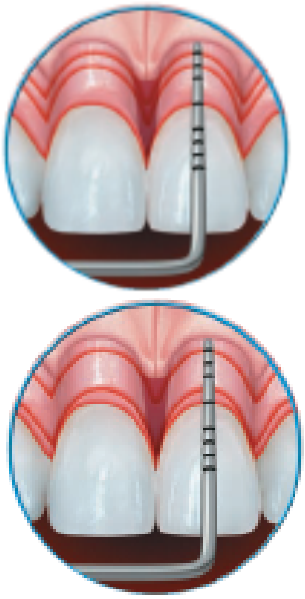

Fig 5: Divisions of Low crest; A: Low Crest Unstable; B: Low Crest Stable

Stable low crest has more substantial attachment apparatus and a significantly shallow sulcus, and so is less susceptible to gingival recession. Stable low crest reacts more like the normal crest (Fig 5B).In order to diagnose Stable or Unstable low crest biologic width, the dentist must perform sulcus probing in addition to bonesounding.[8]

Correction of biologic width violations

Biologic width violation can be corrected by either surgically removing bone away from proximity to the restoration margin or orthodontically extruding tooth and thus moving the margin away from the bone. Surgery is the more rapid way of the two treatment options. It is also preferred if the resulting crown lengthening will create a more pleasing tooth length.

I. **Surgical Crown Lengthening**

Crown lengthening surgery is designed to increase the clinical crown length. Teeth with subgingival caries, fractures, short clinical crowns with or without esthetic deficiencies, and teeth shortened by incomplete exposure of the anatomic crown are all candidates for surgical crown lengthening.

a. *External bevel gingivectomy*: When there is more than adequate attached gingiva and no bone involvement, this method is the one which eliminates excessive pocket depth and exposes additional coronal tooth structure resulting in a longer clinical crown.

b. *Internal bevel gingivectomy*: The external-bevel gingivectomy would remove all or most of the attached gingiva, leaving nothing but alveolar mucosa. If correction of osseous pathology is needed, the flap must be internally beveled so as to expose the supporting alveolar bone.

c. *Apically positioned flap with bone recontouring*: The apically positioned flap technique with bone recontouring (resection)may be used to expose sound tooth structure. It can be done in case of fracture or caries. As a general rule, at least 4 mm of sound tooth structure must be exposed. It is indicated for crown lengthening of multiple teeth in a quadrant or sextant of the dentition. However it should be avoided for single tooth in the esthetic zone.

II. **Forced Tooth Eruption**

Orthodontic tooth movement can be used to erupt teeth in adults. If moderate eruptive forces are used, the entire attachment apparatus will move in unison with the tooth. The tooth must be extruded to a distance equal to or slightly longer than the portion of sound tooth structure that will be exposed in the subsequent surgical treatment. After the tooth has reached the intended position and stabilized, a full thickness flap bone recontouring is performed to expose sound root structure. For esthetic reason it is important that the bone and soft tissue levels at adjacent teeth remain unchanged.

Forced tooth eruption can also be used to level and align gingival margins and the crowns of teeth to obtain esthetic harmony. The tooth that is malpositioned or has sustained recession is erupted to the level of the normally positioned teeth. The entire attachment apparatus and dentogingival junction will follow the root of the tooth as it is moved coronally.

The forced eruption technique can also be used as means of reducing pocket depth at sites with angular bony defects.The angular bony defect at the problem tooth can be reduced while the attachment level at the adjacent tooth surface remains unchanged.

III. **Forced tooth eruption with fibrotomy**

If fibrotomy is performed during the forced tooth eruption procedure, the crestal bone and the gingival margin are retained at their pre treatment location and the tooth-gingiva interface at adjacent teeth is unaltered. Fibrotomy is performed by the use of a scalpel at 7 to 10 day intervals during the forced eruption to sever the supracrestal connective tissue fibers, thereby preventing the crestal bone from following the root in coronal direction.[9-11]

Preservation of biologic width

The restorative dentist must not disrupt the junctional epithelium or connective tissue apparatus during preparation and impression making. Proper margin placement is also necessary for the prevention of biologic width violation. Based on the sulcus depth the following three rules can be used to place intracrevicular margins:

1. If the sulcus probes are 1.5 mm or less, the restorative margin could be placed 0.5 mm below the gingival tissue crest.
2. If the sulcus probes are more than 1.5 mm, the restorative margin can be placed in half the depth of the sulcus.
3. If the sulcus is greater than 2mm, gingivectomy could be performed to lengthen the tooth and create a 1.5 mm sulcus. The patient can then be treated as per rule 1.[8]

Conclusion

Successful restoration is one which restores both esthetics and function with a healthy periodontium. Periodontal health depends on appropriately designed restorations with correctly placed margins without violating the biologic width. Evidence suggests that even minimal encroachment on subgingival tissues leads to deleterious effects on the periodontium. As inter -individual variability exists in the dimensions of biologic width, it has to be evaluated before planning for subgingival placement of the restoration. If dimensions are found to be insufficient, the most appropriate corrective procedure-surgical orthodontics can be undertaken for establishment of sufficient width. The factors to be considered while placing subgingival margins are proper contour, correct polishing and rounding of gingival margins, adequate attached gingiva, careful removal of excess cement, and finally no biologic width encroachment by the restorative margin. Periodic maintenance visits with proper home care are essential for a healthy and functional periodontium around the restored tooth.[12,13]

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OBSTRUCTIVE SLEEP APNEA: AN ORTHODONTIC PERSPECTIVE

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Abstract
Sleep apnea is a leading cause of daytime sleepiness and contributes to CVS disorders. Dental professional's entry into management of upper airway sleep disorders has led to the development of new speciality i.e. 'Dental Sleep Medicine'. Dentists trained in dental sleep medicine, orthodontists & maxillofacial surgeons are recognized members of interdisciplinary team to manage upper airway sleep disorders. So it is paramount importance for dental students and orthodontists to familiarize themselves with the working knowledge of upper airway sleep disorders & their management in order to contribute effectively in managing affected patients.

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Introduction

Sleep apnea, (also spelled sleep apnoea) is a sleep disorder characterized by pauses in breathing or instances of shallow breathing during sleep.[1]Sleep apnoea is the intermittent cessation of airflow at the nose and mouth during sleep. In most cases the apneas last 20-30 s and can last as long as 2-3 min.[2-5] Sleep apnea is a leading cause of daytime sleepiness and contributes to CVS disorders. Its prevalence is 2% in middle-aged women and 4% in middle-aged men.[4]

Pathophysiology

1. Bernoulli's theory
   By the inward suction of pharyngeal structure in a constricted area, causing snores by the vibration of wall structures.

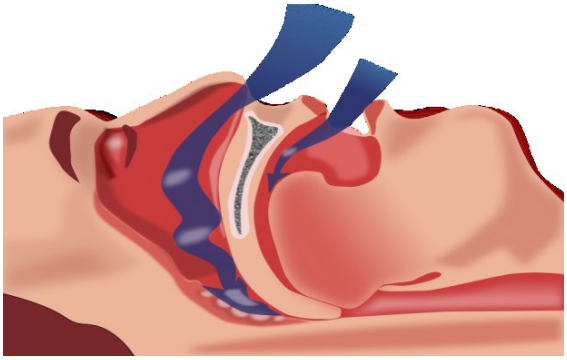

Fig 1: Sleep apnea caused by inward sucking of pharyngeal structures

2. Anatomical variations in the upper airway due to reduced activity of tensor veli palatine & genioglossus muscles.
3. Craniofacial morphology of decreased airway space like
   - Mandibular deficiency
   - Maxillary deficiency
   - Adenoids

- Enlarged tonsils
- Post nasal space tumours
- Short neck

4. Obesity

Apnea

It is the cessation of airflow during sleep which lasts for 10 seconds with oxygen desaturation of more than 3% and / or is associated with arousal.

Hypopnea

It is the reduction in amplitude of airflow of greater than 50% of baseline measurement for at least 10 seconds and /or is associated with arousal. These apnoeic/hypopnoeic spells lasts for 10-30 seconds.

Sleep apnea can be of three types :

1. Central
2. Obstructive Sleep Apnea(OSA)
3. Mixed

Obstructive Sleep Apnea (OSA)

It refers to the occurrence of at least 5 apneas or hypopneas per sleep hour resulting in sleep fragmentation & decreased oxygen saturation. All cases of OSA elicit snoring but all snoring cases need not have OSA.

Pathophysiology

1. Loud snoring
2. Excessive daytime sleepiness
3. Unrefreshing sleep
4. Change in personality
5. Nocturia
6. Morning headaches
7. Reduced libido
8. Nocturnal sweating
9. Worried spouse

Patients may also report with associated disorders like:

a. Hypertension
b. Heart failure
c. Myocardial infarction
d. Ischaemic stroke

Diagnosis and Treatment Protocols

- Case details must include
  1. BMI
  2. Neck size
  3. Alcohol consumption
  4. Sedative usage
  5. Sleep position
  6. Frequency & intensity of snoring
  7. Subjective assessment on Epworth sleepiness scale.
- Treatment modalities of OSA aims to
  1. Increase life expectancy
  2. Decrease disease problems
  3. Improve quality of life

Interdisciplinary approach team should include Sleep Physician, Orthodontist, Otorhinolaryngologist, Nutritionist, Sleep Technician supported by Radiologist, Bariatric surgeon, Maxillofacial Surgeon and a Dental Technician.

Investigations[3,6]

a. Polysomnogram (PSG)– Gold standard
b. Overnight sleep study
c. Dynamic MRI and CT
d. Lateral cephalogram
e. Acoustic reflection test – It is used to determine airway obstruction & corresponding effect of mandibular advancement & protrusion on upper airway.

Management

It includes –

1. Behaviour Modification:
   - Body weight control
   - Sleep position changes
   - Stopping of sedatives/alcohol at least 3 hours before sleep
2. CPAP-Continuous positive airway pressure : Pumping air under pressure through a sealed gauge or nose mask which passes through the upper airway to the lungs
3. Surgical procedures :Maxillomandibular advancement, Palato-uvulo-pharyngoplasty, Hyoid suspension, Genioglossus advancement, Midline glossectomy.
4. Oral Appliances:
   i. Mandibular Advancement Devices
   ii. Tongue Retaining Devices
   iii. Palatal Lifting Devices

Mandibular Advancement Devices(MADs)

They elevate the base of tongue and allows pharynx to expand.

Fig 2: Mandibular Advancement Device

MADs with recorded/fixed mandibular advancement are:

Monoblock appliances

a. A simple splint.
b. Activator.
c. Bionator

Twin block appliances

a. Removable Herbst appliance
b. Twin block

Limitations of MAD

i. Inability to reliably predict treatment outcome.
ii. Needs acclimatization period to attain maximum efficacy of treatment.
iii. Potential long term complications of therapy in relation to TMJ & occlusion.

Tongue Retaining Devices(TRDs)

Introduced by Cartwright in 1982, it is a hollow bulb attached to trays that fit over the maxillary and mandibular arches or edentulous ridges. Patient projects the tip of tongue into the hollow bulb and the appliance is retained by suction.

Fig 3: Tongue retaining devices

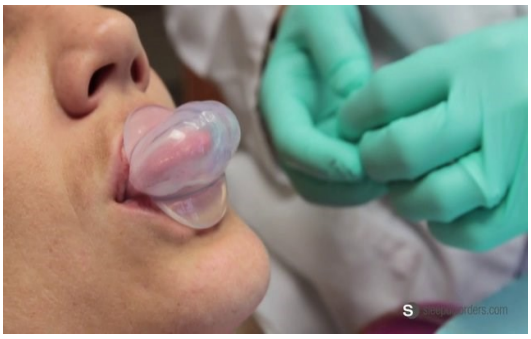

Fig 4: Tongue retaining device in patient's mouth

Tongue Stabilising Devices

It is an improvisation of TRD. Commercially available as AVEO TSD. It does not attach to teeth, and is more of a vestibular appliance. It is made of soft medical silicone. It works by holding tongue forward by gentle suction, preventing fall back, keeping airway open during sleep.

Conclusion

Dental professional's entry into management of upper airway sleep disorders has led to the development of new speciality i.e. 'DENTAL SLEEP MEDICINE'.Dentists trained in dental sleep medicine, orthodontists & maxillofacial surgeons are recognized members of interdisciplinary team to manage upper airway sleep disorders.

So it is paramount importance for dental students and orthodontists to familiarize themselves with the working knowledge of upper airway sleep disorders & their management in order to contribute effectively in managing affected patients.

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OCCLUSION INDICATORS: A GLIMPSE THROUGH THE YEARS

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Abstract

The long-term successful rehabilitation of a mouth with removable or fixed restorations is dependent upon the establishment of an occlusal contact that is harmonious with the position of the condyles and the musculature of the mandible. Any restorative procedure resulting in an occlusal disharmony exceeding the adaptive capacity of human beings can have a sequlae of malocclusion and temporomandibular joint disturbances. Therefore, the recovery of correct physiologic occlusion seems to be of utmost importance which requires a proper understanding of the synergy of the teeth in static and dynamic occlusion. Occlusal indicators are any medium that aids in the detection of occlusal contacts. They help in locating any occlusal interferences and refining the occlusal contacts. Over the years many occlusal indicator materials and techniques have been introduced with each one having its own merits and limitations. A thorough knowledge about various occlusal indicators available, their method of usage, interpretation of their markings and their limitations is essential for making the right choice. Only then accurate adjustments can be made which helps in the establishment of a planned physiologic occlusion for the patient. This article present an overview on various occlusal indicator materials employed in the practice of dentistry.

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Introduction

Prosthetic treatment desires the achievement of a proper occlusion which is in harmony with the remaining natural teeth and supporting structures. The long term success of any fixed or removable prostheses or restorations depends mostly on a physiologically harmonious occlusion. Any occlusal disharmony resulting from a restorative therapy which is exceeding the adaptive capacity of human beings can have deleterious effects on teeth and associated structures.[1,2]

Occlusal interferences may result from a 'supra contact' of a single or multiple anterior or posterior tooth/teeth in maximum intercuspation or on excursive jaw movements. An occlual interference ranging even few microns can trigger severe irritation which may prevent the patient from normal physiologically sound intercuspation position. This could eventually lead to irregular muscle activity and associated myalgia and temporomandibular joint disorders. Therefore attaining a correct

physiologic occlusion seems to be of utmost importance in restorative therapy which remains still as a major challenge for the dentists and technicians. This requires a proper understanding of the synergy of the teeth in static and dynamic occlusion.[3,4]

An occlusal indicator is any medium that aids in the detection of occlusal contacts. Over the years many occlusal indicator materials have been used with each one having its own merits and limitations. A thorough knowledge about the various occlusal indicators available, their method of usage, interpretation of their markings and their limitations is essential for making the right choice. Only then accurate adjustments can be made which helps in the establishment of a planned physiologic occlusion for the patient.[1-5]

Classification

The occlusion indicators can be broadly divided as qualitative and quantitative indicators. With qualitative methods only localization of the occlusal contacts is possible while with quantitative methods along with localization, the sequence and density of the contacts can be differentiated.[3]

Qualitative Indicators

- Carborundum strips
- Typewriter ribbon
- Impression materials
- Articulating paper
- Inter-occlusal wax record
- Foils
- Shimstock films
- Transparent acetate sheet
- High spot indicator
- Occlusal sprays

Quantitative Indicators

- Photo-occlusion
- T-Scan occlusal analysis system
- Pressure sensitive films
- Virtual dental patient

Quanlitative Indicators

Qualitative indicators are the most frequently used materials for registering the occlusion because of their low cost and ease of application. With these materials, only the localization of the occlusal contact points is possible. The main limitation being that the sequence or the density of the occlusal contacts cannot be determined, although an opinion can be derived from the density of the contacts according to the darkness of the marks.

Carborundum Strips

Waterproof carborundum (silicon carbide) abrasive paper had been used earlier as an occlusal adjustment material. It is available in various grits with 220 grit suitable for porcelain teeth and a fine grit of 320 for acrylic resin teeth. It helps in increasing the flatness of the posterior occlusal surfaces of non-anatomic teeth by reducing the high points through abrasive action. It is an economical method, requires less time, and aids in reducing several teeth at one time or a portion of a single tooth.

However the technique is relatively less accurate and pose a disadvantage that when the teeth are in end-to-end as in working occlusion, reductions of both the buccal and lingual cusps will result instead of selective reduction.[4,6]

Typewriter Ribbon

Typewriter ribbon has been used by Ziebert and Donegan[7] in marking the high points or supra contacts in their patients requiring occlusal adjustments. The interferences were initially marked with a typewriter ribbon and contacts were then verified with0.00l-inch shim stock. The occlusal adjustments were accomplished with the rotary instruments.[5]

Impression Materials

Korioth[8] employed alginate impression material to record and analyze the number and location of posterior occlusal tooth contacts in intercuspal position. The impression material was applied to the occlusal surfaces of all lower canines, premolars, and molars on both sides and the subjects were then instructed to close the mouth slowly and press the teeth together with light to moderate pressure until the impression material wasset. The indexes were then examined against light, and the number and location of perforations were registered as occlusal tooth contacts. Durbin and Sadowsky[5] has used polyether rubber impression bites to record and analyze the occlusal contacts in maximum intercuspation before and after orthodontic treatment. Even though the technique employed is relatively accurate it is practically difficult.

Articulating Paper

Articulating papers are the most frequently employed material for marking the occlusal contacts. It is available in different color and thickness (20-200 µm). The width, thickness and dye type of the articulating paper enables it to leave a mark of either a pointor a surface. The color coating of articulating papers consists of oils and pigments, a hydrophobic mixture which can repel saliva and moisture. They are available in strips and horse shoe shaped sheets (Bausch articulating paper Inc., Nashua, NH, USA).High spots leave dark marks and contacts are noted as light marks. Only dark colored spots should be ground during selective grinding.

The main limitation of articulating papers have been that they are thick with a relatively inflexible base material which can result in a greater number of pseudo contact markings. Additionally they can be easily ruined by saliva. However, few manufacturers have produced articulating films with an additional emulsifier (Bausch articulating paper Inc., Nashua, NH, USA) which enhances the bonding properties on moist occlusal surfaces. Special bonding agent- transculase (Bausch articulating paper Inc., Nashua, NH, USA), or wetting agents like lecithin is added to articulating paper coating which had considerably improved the color transfer of these films.[2,3,9,10]

Inter-occlusal Wax Record

Wax has been one of the most commonly employed material to record occlusalcontacts.It is placed on the occlusalsurfaces of the maxillary posterior teeth and patient is asked to close into maximum intercuspation. The occlusal records obtained are examined in front of a light screen. The wax record is verified by placing it on the diagnostic cast to visualize the exact location of each contact (supracontact, contact, and near contact).

However, this methodology has several disadvantages of being inaccurate, unstable and inconsistent.[1,11]

Foils

Foils are the thinnest indicator materials which can give more accurate readings than paper and silk. They are very sensitive and flexible and can detect even minor contacts. However, under reduced pressure and on glossy surfaces, their marking capacity is less evident which necessitates greater pressure application in clinical use.[4,12,13]

Shimstock films

Shimstock film is made of metallic polyester 12 micron film. This articulating film easily detects high spots, especially on ceramic or highly polished metal surfaces. The film is placed in mouth and is evaluated with the patient in maximum intercuspation position. The teeth holding the shimstock were considered to have occlusal contact with their antagonists. It has excellent color transfer and can easily be applied without using forceps. It is more reliable than the articulating film and is suitable for representing static and dynamic occlusion in several colors.[3,5,13]

Transparent Acetate Sheet

Davies et al has introduced a clinical method termed the ‘‘occlusal sketch’’ technique as a means of recording occlusal contacts. The sketch consists of an acetate sheet on which a schematic representation of the teeth is drawn, including the occlusal surfaces of the posterior teeth, the palatal surfaces of the maxillary anterior teeth, and the labial surfaces of the mandibular anterior teeth. It provides a simple and reliable means of recording and transferring information about the location of marked occlusal contacts. The occlusal assessment process involves marking teeth contacts using articulating paper and then transferring this markings onto the occlusal sketch. The technique is quick, simple, inexpensive means of recording static and dynamic occlusal contact marks with a high degree of reproducibility.[4,5,14]

High Spot Indicator

It is a contact color (Bausch Arti-Spot Highspot-Indicator) for testing the accurate fit of crowns, inlays, onlays, telescoping crowns and clasps. It is available as a solution and can be applied with a brush. On application the solvent evaporates in seconds, leaving a thin film of 3µ thick. The color skin is destroyed exactly at the point of contact which makes the base material to shine clearly through and thus aiding in detection of high spots. The food dye contained in the solvent is completely safe and can easily be removed after use with hot water or alcohol. It is extremely useful in testing high spots on highly polished occlusal surfaces such as gold or ceramic.[3,5]

Occlusal Sprays

It is a universal color indicator to test the occlusal contacts and accurate fit of crowns and bridges. It is a solution which are available in different colors(red, blue, green and white) and can be applied in spray form. It is easy to administer (Bausch Arti-Spray Occlusion-Spray) and leaves a thin colored film which can easily be removed with water,

leaving no trace of residues. They are usually applied from a distance of 3-5 cm onto the occlusal surface. The contact points can be easily visible while evaluating the occlusion even on polished and glazed surfaces.[4,5]

Selection of the Qualitative Indicators

The selection of appropriate indicator should be based on various parameters that can influence their sensitivity, reliability, accuracy and reproducibility. This will enable the verification of centric occlusion mounting on a hinge articulator, the occlusal accuracy of wax-ups and the occlusal contact of newly restored teeth and establish the contact of unrestored teeth. It also serves to locate the working and balancing interferences.

- Thickness: It is desirable to have minimal thickness for the indicators. The disadvantage of a thick occlusal registration strip, is that it can indicate the tooth contact between the opposing teeth, even when no contact exists (pseudomarkings).Moreover, excessive thickness can disturb the proprioceptive responses that in turn can cause the jaw to be deflected thereby preventing the patient in achieving physiologic occlusion.
- Flexibility / Plastic deformation: Occlusal registration strips that have plastic deformation will flex according to the occlusal surface contours, thereby enabling the dentist to tug at the strip and to evaluate the occlusal contact.
- Tensile strength: Thinner strips would tear before they serve their purpose, but those having the sufficient tensile strength will stretch prior to tearing.
- Marking ability: On occlusal contact, the coloring agent should bond to the tooth. Articulating foils have the greatest marking sensitivity values, followed by the articulating paper. It has been found that the marking ability of all qualitative recording media is negatively affected by the presence of saliva, and hence, the teeth should be dried prior to the use of the registration strips.[3,9,13]

Quantitative Indicators

These include relatively newer techniques and materials which can locate the contact points and at the same time can differentiate the sequence and density of the contacts.

Photo-Occlusion

In a photo occlusion system, a thin photoplastic film layer is used to detect the occlusal contact points. The photoplastic film layer is placed on the occlusal surface of the teeth and the patient is asked to occlude on the film layer for 10to 20 seconds. The film layer is removed from the mouth and inspected under a polariscope light after applying coltene paste (Coltene pressure spot indicator, Alstatten, Switzerland) to the maxillary surface of the memory wafer. The results are then transferred to a graphic occlusal scheme to examine the location and intensity of occlusal contacts.

The chances of false negative results are minimal with this technique if the record is made accurately. Additionally it can

eliminate the moisture problem and can serve as a permanent record of the occlusal contacts. However the firm plastic sheet can impair the proprioceptive reflexes and may apply pressure against the cheeks, lips, tongue, or retromolar tissue which can distract the mandibular closure.[4,15,16]

T-Scan

The T-Scan occlusal analysis system (T-Scan; Tekscan Inc., South Boston, Mass) is a computerized occlusal analysis which was first reported by Mannes et al. It is a Microsoft compliant system that can record a given contact sequence in 0.01-s increments. It consists of a piezoelectric foil sensor, a sensor handle, both hardware and software for recording, analyzing and viewing the data. The T-Scan identifies the time magnitude and the distribution of the occlusal contacts.

In this system, electrical resistance fluctuateson the sensor with the applied force. When the patient occludes on the sensor, the particles come together in the force applied areas, diminishing the electrical resistance. The u-shaped sensor foil is 60microns thick, consists of an X-Y coordinate system with 1500 sensitive receptor points made of conductive ink, which is subject to elastic deformation. The tooth contact information is presented by demonstrating moments of time in the sagittal axis and transverse axis of the occlusal plane. Time moments are defined as the sum of distances of the tooth contacts in millimeters from the x or z axis of the occlusal plane multiplied by their relative time value (1-sec) and divided by the sum of the onset times. By analyzing the time moment on these axes an occlusion can be uniquely described.

This device is indicated in any situation where the bilateral simultaneous occlusal contact is necessary including complete dentures, fixed or removable partial dentures, implant supported prostheses, and even in natural tooth occlusal equilibration. However the clinical applicability of the T-Scan system is limited as the system has many dilemmas to encounter. It has been reported that the sensors donot have the same accuracy among themselves and have fewer contacts than conventional methods. Also the sensitivity of the sensors were found to be diminished when used more than once.[2,3,10,17]

Pressure Sensitive Films

It is a newer but essentially similar device as T-scan which was introduced in Japan (Dental Prescale, Fuji Film, Tokyo, Japan). This device records the location and force of contacts with a force sensitive film. A study analyzing the reliability of this device in occlusal force measurement showed a linear relationship between the applied and measured load. The primary limitation of the pressure sensitive film device is that the recording medium is far too thick which results in heavier contacts on the posterior teeth than the anterior teeth. Further, this sensor thickness disturbs the persons finding attempts to close into the intercuspal position.[4,5,18]

Virtual Dental Patient

This is a recently introduced method that provides a possible tool for noninvasively measuring occlusal

interactions by use of 3-Dcomputer renditions of dental arches. In this method digital images of the patient's hard and soft tissues are related to each other by use of computer software to create a "virtual dental patient" (VDP). This provides quantitative information that would identify and measure occlusal wear and changes in the patient's hard and soft tissues including occlusal contacts. Further, the sequential comparison of these occlusal contacts enables the dentist to identify the changes in the patient's occlusion as time elapses. The preferred method of calculating contacts uses virtual casts aligned with virtual interocclusal records.[4,19]

Conclusion

A wide range of occlusal registration materials have been used since years for recording the occlusal contacts. Many new techniques have also been introduced with each one carrying its own advantages and disadvantages. Qualitative recording materials can establish the location and number of contacts. But their marking ability is negatively affected by the presence of saliva or moisture. However these materials are primarily preferred because of their low cost and ease of application. Newer quantitative techniques like T-Scan system identifies the time and force characteristics of occlusal contacts, and hence, establishing true and measurable bilateral simultaneous occlusal contacts. The choice to use any one out of the above mentioned materials depends upon the clinical situation, affordability, reliability and thorough knowledge about materials by the clinician.

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DENTAL TISSUE DERIVED STEM CELLS- AN OVERVIEW

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Abstract

Tissue engineering is an emerging field of science that focuses on creating suitable conditions for the regeneration of tissues. The basic components for tissue engineering involve an interactive triad of scaffolds, signaling molecules, and stem cells. Mesenchymal stem cells (MSCs) derived from bone marrow (BMMSCs) which are widely used are capable of giving rise to various lineages of cells, such as osteogenic, chondrogenic, adipogenic, myogenic, and neurogenic cells. However, researchers have shown that a rich source of mesenchymal stem cells can be easily isolated from the dental tissues: dental pulp stem cells (DPSCs), stem cells from exfoliated deciduous teeth (SHED), periodontal ligament stem cells (PDLSCs), stem cells from apical papilla (SCAP), and dental follicle progenitor cells (DFPCs). All these MSC-like cells exhibit self-renewal, multilineage differentiation potential, and immunomodulatory properties. Being such an accessible source for different stem cells, the dental tissue derived stem cells (usually discarded in the clinics) represent an ideal source of autologous or allogenic stem cells that can be used in the treatment of many clinical conditions in dentistry and medicine. This article outlines the properties of various dental MSC-like populations and the progress toward their use in regenerative therapy. Dental stem cell banking is also introduced, with a view toward future clinical application.

Keywords: Mesenchymal stem cells, dental pulp stem cells, periodontal ligament stem cells, stem cells from apical papilla, dental follicle progenitor cells , stem cells from exfoliated deciduous teeth,tissue engineering

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Introduction

Tissue engineering is a multidisciplinary field that combines biology, engineering, and clinical science with the goal to replace or regenerate human cells, tissue or organs, to restore or establish normal function. It is a science based on fundamental principles that involves the identification of appropriate stem cells, the development of scaffolds and morphogenic signals required to induce regeneration.[1,2]

The main characteristics of stem cells include the ability to self-renew and also to differentiate into multiple cell types which make them promising candidates for regenerative procedures.[3,4] They can be isolated from embryo (embryonic SCs) or various postnatal adult tissues (Adult SCs).

Although embryonic SCs have the ability to differentiate into hundreds of other cell types i.e pluriepotent, the bioethical issues involved in their study have hindered advances in this field and research. Adult SCs can be obtained from adult specialized tissues, such as bone marrow, skin, dental tissues, and fat where they likely act to renew cell populations and maintain tissue homeostasis, or help to repair the tissue in case of injury. These cells have certain limitations like decreased lifespan and reduced differential potential (multipotent). However, the use of adult stem cells is less controversial because they can be harvested without destroying an embryo. In order to overcome the drawbacks of adult SCs, researchers have reprogrammed them by the insertion of SC-associated genes, leading to the formation of induced pluripotent SCs (iPSCs). iPS cell technology can derive patient-specific stem cells allowing extraction of tissue-matched differentiation donor cells for basic research, and regenerative medicine.[1,4,5]

This review focus on the dental tissue derived stem cells and discuss the perspectives for their use in regenerative approaches and how the dentist will become the link between regenerative research and medical treatments.

Dental Stem Cells

Dental stem cells can be collected from deciduous teeth when they naturally exfoliate at approximately 6 to 11 years, and also from teeth that are surgically removed, such as premolars for orthodontia and third molars during wisdom teeth extraction. Dental stem cells allow for autologous use, meaning the adult stem cells can be collected from and used on the same person, so there are no issues of immunological incompatibility. It has also been shown that the pluripotency of dental stem cells may be a function of the age of the tooth or the age of the donor (Fig 1). It is said that apart from differentiating into periodontal ligament alveolar bone, cementum, dentine, and enamel they also have potential to switch lineage into other ectodermal and endodermal tissues such as neurons, epithelial-like cells, hepatocytes and insulin producing cells.[6]

The first type of dental stem cell was isolated from the human pulp tissue and termed 'postnatal dental pulp stem cells' (DPSCs) (Gronthos *et al.*, 2000). Subsequently, 3 more types of dental-MSC-like populations were isolated and characterized: stem cells from exfoliated deciduous teeth (SHED) (Miura *et al.*, 2003), periodontal ligament stem cells (PDLSCs) (Seo *et al.*, 2004), and stem cells from apical papilla (SCAP) (Sonoyama *et al.*, 2006, 2008). Recent studies have identified a fifth dental-tissue-derived progenitor cell population, referred to as 'dental follicle precursor cells' (DFPCs) (Morsczeck *et al.*, 2005)[7] (Fig 2).

Dental pulp stem cells (DPSCS)

DPSCs were the first type of dental stem cells to be isolated. These cells were obtained by enzymatic digestion of the pulp tissue of the human impacted third molar tooth. DPSCs have a typical fibroblast-like morphology.[5] They are clonogenic in nature

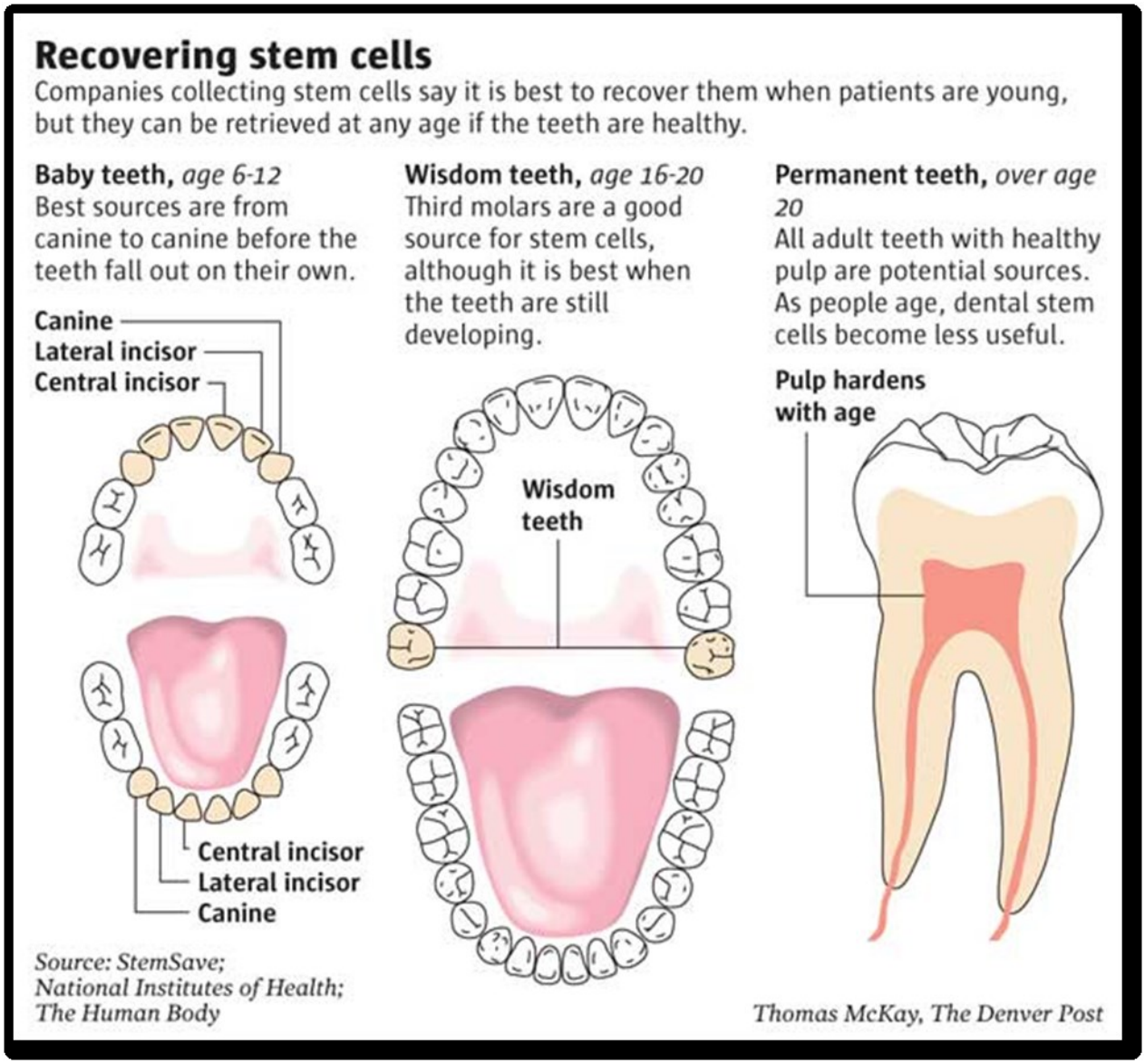

Fig 1: Recovering stem cells from teeth in various ages

and can maintain their high proliferation rate even after extensive subculturing. DPSC's express several markers including the mesenchymal and bone marrow stem cell markers, STRO-1 and CD146 as well as the embryonic stem cell marker, Oct4. Culturing DPSCs with various differentiation media demonstrated their dentinogenic, osteogenic, adipogenic, neurogenic, chondrogenic and myogenic differentiation capabilities. Following their transplantation in animal models, DPSCs were able to maintain their self renewal and to form pulp-like tissue, odontoblast-like cells, ectopic dentin as well as reparative dentin-like and bone-like tissues. Dentin and pulp-like tissues were generated following the transplantation of DPSCs into the hydroxyapatite /tricalcium phosphate (HA/TCP) scaffolds in the mice which were immunodeficient.[2,5] The microenvironment of the dental pulp is auspicious for the stem cells, because of the lack of oxygen and nutrients, due to the low diameter of the apical foramen.[8]

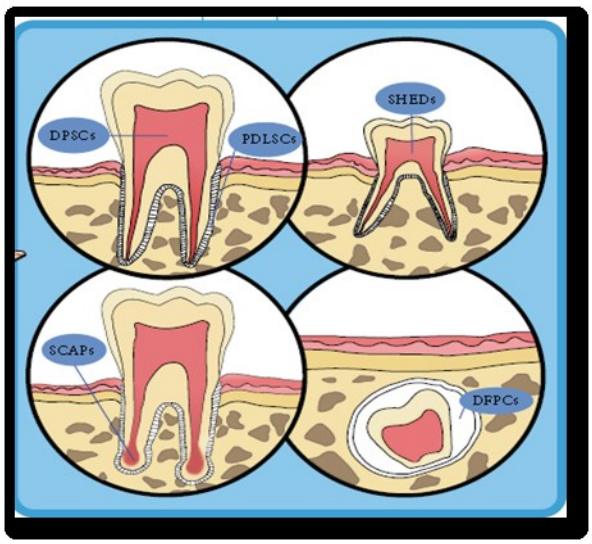

Fig 2: Dental tissue derived stem cells

Stem cells from human exfoliated deciduous tooth (SHED)

In 2003, Miura *et al*. isolated cells from the dental pulp which were highly proliferative and clonogenic. The isolation technique was similar to those used in the isolation of DPSCs. However, there were two differences: i) the source of cells was the pulp tissue of the crown of exfoliated deciduous teeth and ii) the isolated SHEDs did not grow as individual cells, but clustered into several colonies which, after separation, grew as individual fibroblast-like cells. SHEDs have a higher proliferation rate and a higher number of colony forming cells than BMSCs and DPSCs in various studies. SHEDs were found to express early mesenchymal stem cell markers (STRO-1 and CD146), embryonic stem cell markers such as Oct4, Nanog, and tumor recognition antigens (TRA-1-60 and TRA-1-81). These stem cells can produce dentin and are very important in neurodegenerative diseases by their secretion of neurotrophic factors. When SHEDs were cultured with neurogenic inductive media, they formed sphere-like clusters and changed their fibroblastic morphology into cells with multiple cytoplasmic processes and produced glial cell markers such asnestin. When SHEDs were transplanted into immune-compromised mice, dentin-like structure was formed.[2,5,8,9] In addition, SHED can specifically induce the formation of a bone-like matrix with a lamellar structure by recruiting host cells.[10]

Periodontal ligament stem cells (PDLSCs)

In 2004, the third type of dental stem cells referred to as PDLSCs were found to express STRO-1, CD146 and scleraxis (tendon specific transcription factor)[5]. PDLSCs have the capability to differentiate into cementoblast-like cells, adipocytes, and fibroblasts that secrete collagen type I. As with BMMSCs, PDLSCs can undergo osteogenic, adipogenic, and chondrogenic differentiation[2]. It was reported that PDLSC could differentiate into cells that can colonize and grow on biocompatible scaffold, suggesting an easy and efficient autologous source of stem cells for bone tissue engineering in regenerative dentistry. Orciani *et al* verified the osteogenic ability of PDLSC and pointed out that differentiating cells were also characterized by an increase of Ca^{2+} and nitric oxide production.[11] When transplanted into immunocompromised mice, the induced PDLSCs showed tissue-regenerative capacity to produce cementum/periodontal ligament-like structures, characterized by a layer of cementum-like mineralized tissues connected with periodontal ligament-like collagen fibers.[12]

Stem cells from the dental follicle

In 2005, Morsczeck *et al*. were successfully able to isolate stem cells from the dental follicle of the human impacted third molar, using the same methodology of DPSCs isolation and culture. The cells were fibroblast-like and expressed various markers, such as nestin and Notch-1. The potential of DFPCs to undergo osteogenic, adipogenic and neurogenic differentiation was demonstrated using *in vitro* studies. Dental follicle stem cells (DFSCs) can give rise to three major cell types in peri-odontium: cementoblasts, osteoblasts, and fibroblasts. A recent study from Bay *et al.* showed that co-culture of DFC with Hertwig epithelial root sheath cells *in vitro* enhances the ability of these cells to regenerate cementum and periodontal ligament after transplantation.[3,5].Both DFPCs and SHED cells can differentiate into neural cells; however, these are differentially expressed when the cells are grown under the same culture conditions.[8] When the neurogenic differentiation potential of DFPCs was compared with that of SHEDs, different neural cell marker expression patterns were revealed suggesting different neuronal differentiation potential.[5]

Stem cells from dental apical papilla (SCAP)

Stem cells from the apical part of the papilla are a precursor tissue of the dental pulp. Impacted third molars serve as a suitable source. In vitro, it has been found that SCAP can differentiate osteogenically, odontogenically, and adipogenically. In vivo SCAP have been found to differentiate into odontoblasts and osteoblasts. The potential to regenerate dentin is greater with SCAP when compared to DPSC. In 2006, Sonoyama *et al*. isolated a new population of dental stem cells, and called them SCAPs. SCAPs are clonogenic fibroblast-like cells, but have a higher proliferation rate than DPSCs[5].SCAP appear to be a source of primary odontoblasts responsible for the formation of root dentine, whereas DPSCs are possibly the source of replacement odontoblasts that produce reparative dentine[3].As other dental stem cells, SCAPs express the early mesenchymal surface markers, STRO-1 and CD146. However, SCAPs also express CD24, which could be a unique marker for this cell population. Thus, SCAPs have the capacity to undergo osteogenic, adipogenic, chondrogenic and neurogenic differentiation, when they are cultured in the appropriate inductive media.[5]

Induced pluripotent stem cells and dental pulp pluripotent like stem cells (IPSCS)

In breakthrough studies in 2006 and 2007, investigators described methods by the insertion of 4 genes (OCT3/4, SOX2, KLF4, and MYC) to reprogramme the somatic cells and return them to an embryo-like state. The resultant induced pluripotent stem (iPS) cells have embryonic stem cell characteristics: they are capable of generating cells from each of the 3 embryonic germ layers and can propagate in culture indefinitely. [2]While this technology avoids the ethical issues of embryonic stem cells and uses the patient's own tissues, thus reducing immunologic incompatibility, induced pluripotent stem cells have also been shown to cause teratomas and are expensive to generate.[6]

Clinical applications of dental stem cells

In the field of medicine, SCs have become the subject of interest to regenerate damaged tissues and a way of resolution of various diseases like Parkinsonism, diabetes, Myocardial infaraction etc. In dentistry, tissue engineering is also considered to be a new frontier in the regeneration of missing oral tissues/organ. Stem cell and tissue engineering therapies are expected to provide a novel capability to regenerate large defects in periodontal tissues and alveolar bone, and to ultimately replace the lost tooth itself.[10] This section is intended to provide a brief overview of the tremendous potential of dental stem cells in clinical dentistry and medicine.

Current applications

Alveolar Bone Regeneration – Dental stem cells were used in humans to regenerate dental bone in human clinical studies. Defects of at least 1.5 cm in the alveolar ridge of human volunteers were filled with a construct of stem cells collected from third molars and seeded onto a collagen matrix. One year later in many cases, the gap was filled with bone.[13] The role of DPSCs in bone regeneration around dental implants was recently investigated, and a similar study performed with BMSCs and PDL cells showed that DPSCs exhibit the highest osteogenic potential as a source for tissue-engineered bone around titanium implants. Regarding alveolar bone regeneration, PDLSCs demonstrated promising results[9].A clinical study revealed that when a collagen sponge scaffold with dental pulp stem/progenitor cells (DPCs) is transplanted into the mandible, oro-maxillofacial (OMF) bone tissue repair with a good vascularisation and lamellar architecture was achieved after one year of the engraftment.

Periodontal Ligament—Various studies have been reported in literature attempting PDL regeneration. Feng, et al demonstrated clinical and experimental evidence supporting the safe and efficacious use of autologous PDL cells to treat periodontitis in 3 humans in a multiyear study. Endogenous regenerative technology "ERT"-Cell transplantation is a new method of tissue engineering to treat attachment loss. There are two approaches cell homing and cell transplantation. In Cell homing, the PDL cells harvested from the patient may be cultured in vitro as a monolayer of cells without a substrate. This is placed in vivo against the tooth surface to repair the periodontal defect. In cell transplantation, cultured in a 3 dimensional polymer matrix and this is implanted back into the periodontal defect site.[14-16]

Future developments

Pulp Regeneration—The use of stem cells to regenerate dental pulp tissues is being studied as an alternative method to conventional root canal treatment.Stem cell therapy has been attempted for regeneration of dentin pulp complex using SCAP, SHED, gingiva derived stem cells.[17]

Third dentition (bioengineered teeth)—Honda et al in his review article provided an overview of recent advances in tooth regeneration, tissue engineering approaches as well as a description of the first study of

tooth-tissue engineering. First tooth regeneration was done in ectopic sites like rat omentum with help of postnatal stem cells seeded into PGA. But the most meaningful site is the jaw, which is the appropriate final location of fully developed teeth. The authors tested whether the transplantation of dissociated dental cells could produce a regenerated tooth in the canine jaw. Alternatively, instead of whole tooth replacement we can envisage a partial replacement of the tooth by engineering the tooth root. This represents a root-shaped dentin mass associated with the periodontium including cementum, PDL and alveolar bone.[18,19] Sonoyama et al. developed the 'bio-root' by using PDLSCs and stem cells from apical papilla with tooth root-shaped hydroxyapatite tricalcium phosphate (HA/TCP), and showed the formation of PDL tissue on the surface of the 'bio-root' when transplanted in swine. Although they did not show apparent cementum deposition on the HA/TCP, Wei F et al improved the 'bio-root' by utilizing the PDLSC sheet, showing the defined periodontal tissue structure including cementum-like formation.[20,21]

Biohybrid implants- A group of Japanese researches constructed a novel fibrous connected tooth implant using a HA-coated dental implant enveloped with dental follicle stem cells which would act as a bio-hybrid organ. This bio-hybrid implant restored physiological functions, including bone remodelling, regeneration of severe bone-defect and responsiveness to noxious stimuli, through regeneration with periodontal tissues. This would be a significant advancement in the development of a next-generation therapeutics for the treatment of tooth loss[15,22] (Fig 3).

Cranial-facial structures—Human dental stem cells isolated from deciduous teeth were useful for correcting large cranial defects in rats, providing a promising model for reconstruction of large cranial defects in craniofacial surgery. There are various studies in animal models showing reconstruction of salivary gland tissue, mandibular condyle and also tongue regeneration using stem cell based tissue engineering.[16]

Other uses: Human dental stem cells were used to successfully treat an animal model for cornea damage, liver damage and cardiac repair.

Diabetes - The use of stem cells to treat diabetes is focused on 2 fronts: developing cells that secrete insulin in a glucose-responsive manner, and using MSCs to regulate the immune response by inducing tolerance to pancreatic antigens. Dental stem cells therefore represent an easily available source of stem cells for potentially both of these therapeutic approaches to diabetes.

Stroke—Neuronal stem cells from human third molars have been used to treat a rat model of middle cerebral artery exclusion (induced stroke) showing decreased neurologic dysfunction.

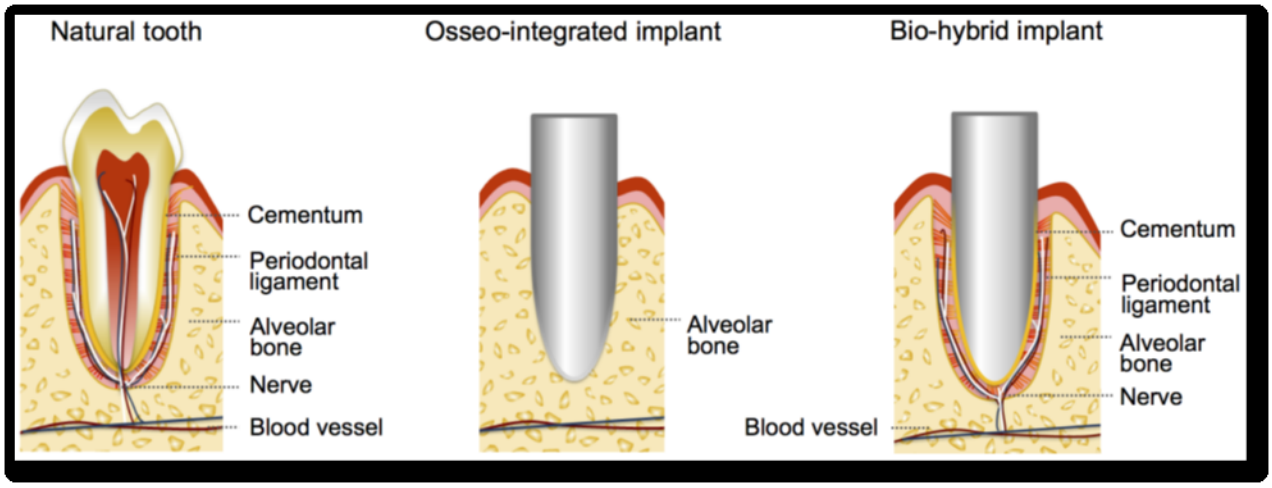

Fig 3: Biohybrid Implants

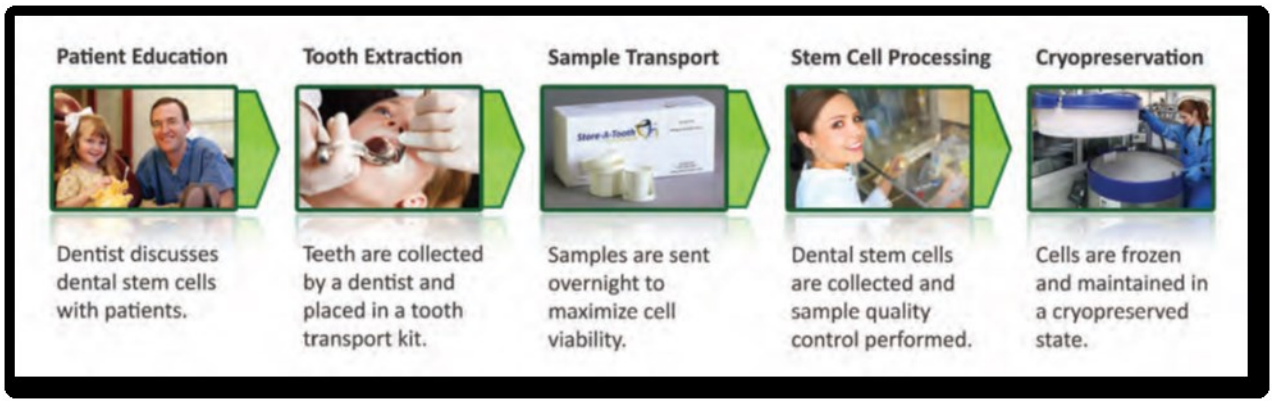

Fig 4: Stem cell banking

Spinal Cord Injury and Other Neurological Diseases/ Disorders- In animal models, dental stem cells have been found to mediate the inflammatory process by secreting factors , direct axon growth, and even provide a source of neurons for cell therapy suggesting that they could play an important role in treating human spinal cord injury and neurodegenerative diseases such as Parkinson's disease.[6]

Stem Cell Banking

After the tooth or teeth sample is collected by the dentist, the sample is transported from the dentist office to the laboratory as quickly as possible in a sterile, isotonic solution, shipped chilled to reduce the growth of contaminating microbes. Cryopreservation of cells typically involves equilibrating the cells with a cryoprotectant solution—a solvent that protects the cells from the formation of ice crystals and that helps preserve the integrity of cell membranes upon thawing. The temperature is typically slowly brought down to freezing using programmable controlled-rate freezers. Frozen cells are then transferred to vapor-phase liquid nitrogen freezers for long-term storage at ultra-low temperatures, typically at about -150°C.[2,6](Fig 4).

Conclusion

Medicine and dentistry are on the cusp of a new treatment modality. For both physicians and dentists to take advantage of this new modality, not only do the clinical applications need to be further developed, but sources of stem cells from teeth will be necessary. Similar to umbilical cord blood, teeth are one of the few tissues in the body that are naturally shed (or extracted during the normal course of dental care) that contain potent stem cells, creating an opportunity to save this tissue for when it is needed. Dentists and patients need to be aware that the option exists to preserve the stem cells from healthy extracted or exfoliating teeth as a resource for these future clinical applications.

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IMPLANT SURFACE MODIFICATIONS

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Abstract

Osseointegration, the direct structural-functional adhesion between bone and implant surface, is a prerequisite for the long-term success of dental implants.The osseointegration rate of dental implants is related to their composition and surface roughness. The interfacial zone between the implant and the bone is composed of a relatively thin layer (<100um) which consists of heterogenous metallic oxide, proteins and connective tissue.Bone implant interface is controlled by the selection and modification of the biomaterial through morphological, physiochemical and biochemical methods.The different methods used for increasing surface roughness or applying osteoconductive coatings to the dental implants are reviewed.

Keywords: Osseointegration, implant surface, implant interface, implant surface modification

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Introduction

Implant is defined as "a prosthetic device made of alloplastic material implanted into the oral tissues beneath the mucosa, periosteal layer, and on or within the bone to provide retention and support for a fixed or removable dental prosthesis".[1] Over the past 20 years, the number of dental implant procedures has increased steadily worldwide, reaching to about one million dental implantations per year. However, not all of these have achieved a favorable result. For an implant to be successful it must integrate with the surrounding hard tissues prior to prosthetic rehabilitation.

Osseointegration and the implant factors

Osseointegration, the direct structure-function adhesion between bone and implant surface, is a prerequisite for the long-term success of dental implants. It is attained by cellular processes that contribute to bone formation at the alloplastic surface. Molecular and cellular contributions to endosseous implant osseointegration include factors that affect bone formation and bone adaptation. Many investigations indicate the possible use of growth factors, matrix molecules, or cells to enhance or augment bone formation at implants.Bone maintenance depends on continuous adaptation to functional loading and repair of damage subsequent to overload at the implant-bone interface. An alternate avenue for improving osseointegration is and has been implant surface technology. Implant features significantly influence the formation and maintenance of bone at implant surfaces.[2]

Albrektsson et al suggested the following as the six most important factors for establishing reliable osseointegration: (a)

implant material, (b) implant design, (c) implant surface quality, (d) bone status, (e) surgical technique, and (f) loading conditions. Of these, surface structure is the most critical factors influencing the clinical outcome of implants.[3]

The surface quality of an implant depends on the chemical, physical, mechanical and topographical properties of its surface. Several implant surface modifications have been used to improve the quantity and quality of the bone-to-implant interface. Surface composition and roughness are parameters that may play a role in implanttissue interaction and osseointegration.[4]At least five important effects have been attributed to increased surface roughness, they are (a) increased surface area of the implant adjacent to bone, (b) improved cell attachment to the implant surface, (c) increased bonepresent at the implant surface, (d) increased biomechanical interaction of the implant with bone, and (e) promoted inflammation of the peri-implant mucosa if the rough surface is located in a transmucosalarea.[2,4]Still, there has been a growing demand for implants with better surface features and consequently better osseointegration, therefore the topography of the implant surfaces can now be manipulated at a wide range of length scales, down to the nano level.

Implant surfaces have been classified by Wennerberg based on different criteria, such as roughness, texture and orientation of irregularities.

A) Based on the surface roughness as:
   - Minimally rough (0.5-1 um)
   - Intermediately rough (1-2 um)
   - Rough (2-3 um)

B) Based on texture obtained, the implant surface can be divided as:
   - Concave texture (mainly by additive treatments like hydroxyapatite (HA) coating and titanium plasma spraying)
   - Convex texture (mainly by subtractive treatment like etching and blasting)[5]

C) Based on the orientation of surface irregularities, implant surfaces are divided as:
   - Isotropic surfaces: have the same topography independent of measuring direction.
   - Anisotropic surfaces: have clear directionality and differ considerably in roughness.[6,11,13]

The bone implant interface

The interfacial zone between the implant and the bone is composed of a relatively thin layer (<100um) which consists of heterogenous metallic oxide, proteins and connective tissue. Bone implant interface is controlled by the selection and modification of the biomaterial.[7]Different approaches are employed to obtain desired outcomes at the bone implant interface. As a general rule, an ideal implant biomaterial should present a surface that will not disrupt, and that may even enhance, the general processes of bone healing, regardless of implantation site, bone quantity and bone quality. As described by Ito et al. the approaches to alter implant surfaces can be classified as physicochemical, morphologic or biochemical.[8]

Physicochemical method

It mainly involves the alteration of surface energy, surface charge, and surface composition with the aim of improving the bone-implant interface. The method employed is the Glow discharge treatment, in which materials are exposed to ionized inert gas, such as argon. During collisions with substrate, high energy species "scrub" contaminants from the surface, thereby unsaturating surface bonds and increasing surface energy. This higher surface energy will then influence adsorption of biomolecules, which in turn affects subsequent cell and tissue behaviour. However improved interactions with bone have not been demonstrated. Fluoride surface treatments, anodized surface implants, laser etching and micro arc oxidation are the other methods used.

Based on biomechanical and histomorphometric data, the fluoride modified titanium implants demonstrated a firmer bone anchorage than the unmodified implants, after a short healing period. The formation of fluoridated HA and flourapatite in the calcified tissues has been demonstrated. The increased seeding rate of the apatite crystals, the stimulation of the osteoprogenitor cells, an increased alkaline phosphatase activity and the incorporation of newly formed collagen into the bone matrix are the reported effects of the fluoride modification. Anodized surface implants are implants which are placed as anodes in galvanic cells, with phosphoric acid as the electrolyte and current is passed through them. The surface oxides grow from the native state of 5nm to approximately 10,000nm.

The implants which are modified by micro-arc oxidation show an increased bone response as an increased cell contact, spread and removal of the torque as compared to the turned implants. The laser etching method is a process which can be used to produce an implant surface with enough roughness for good osseointegration. [4,7,9,12]

Morphological methods

It mainly deals with alteration of surface morphology and roughness to influence cell and tissue response to implants. Machined and blasted surface, surface coatings and texturing are the different methods used. The term ‘machined surface’ is often used as a description of a turned, milled or sometimes a polished surface. The turned surface has an average roughness of 0.96µm and an average peak spacing of 8.6µm. Blasting the implant screws with 25-75µm alumina particles results in an isotropic surface with average height deviations of 1.1 and 1.5µm respectively. Blasting with 250µm alumina particles results in a less isotropic surface andan average height deviation of about 2.0µm. HA coating on the implant surface (50-70µm) is achieved by plasma spraying, the vacuum deposition techniques, electrolytic process, sol-gel and dip coating methods. Many animal studies support that bone ingrowth into macro rough surfaces enhances the interfacial and shear strengths. In addition; surfaces with specially contoured grooves can induce contact guidance, whereby direction of cell movement is affected by morphology of substrate. The added advantage is that this method prevents the epithelial down growth on dental implants.[4,7]

Biochemical Methods

The biochemical methods of the surface modifications offer an adjunct to the physiochemical and the morphological methods. Their goal is to immobilize proteins, enzymes or peptides on biomaterials for the purpose of inducing specific cell and tissue responses, or in other words, to control the tissue-implant interface with molecules which are delivered directly to the interface. One approach uses cell-adhesion molecules like fibronectin, vitronectin, TypeI collagen, osteogenin and bone sialoprotein. The second approach uses biomolecules with osteotropic effects which range from mitogenicity (interleukin growth factor-I, FGF-2, platelet derived growth factor –BB) to the increasing activity of the bone cells, which enhances the collagen synthesis for osteoinduction.[7,10]

The arrival of nanotechnology has opened new opportunities for the manipulation of implant surfaces. It is believed that implant surfaces could be improved by mimicking the surface topography formed by the extracellular matrix (ECM) components of natural tissue. These ECM components are of nanometre scale with typical dimensions of 10-100 nm. Cell attachment, proliferation, and differentiation are responsive to nano-scale features such as pillars or grooves prepared, for example, using nanolithography. Nanopatterned surfaces may also provide better adhesion of the fibrin clot that forms right after implantation, facilitating the migration of osteogenic cells to the material surface.[4]

Conclusion

There are a number of surfaces commercially available for dental implants. Most of these surfaces have proven clinical efficacy (>95% over 5 years). However, the development of these surfaces has been empirical, requiring numerous in vitro and in vivo tests. The exact role of surface chemistry and topography on the early events of the osseointegration of dental implants remain poorly understood. The various methods of modifying the implant surface have been listed, and these techniques have greatly influenced the quality of clinical service in implant prosthodontics. Furthermore, comparative clinical studies with different implant surfaces are rarely performed. The future ofdental implantology should aim at developing surfaces with controlled and standardized topography or chemistry.

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ANGLE: FROM A DIFFERENT ANGLE

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***Dr. Rahul C.S, ***Dr. Deepa Menon, ***Dr. Bijoy N. V.

Abstract

Edward Hartley Angle was an American dentist, widely regarded as "the Father of Orthodontics". He was trained as a dentist, but made Orthodontics his speciality and dedicated his life to standardizing the teaching and practice of Orthodontics. The development of Angle's classification of malocclusion in the 1890s was an important step in the development of Orthodontics because it not only subdivided major types of malocclusion but also included the first clear and simple definition of normal occlusion in the natural dentition. Much of what is known about Edward Hartley Angle, the acknowledged "Father" of modern Orthodontics, has been derived from secondary sources, accounts written by his contemporaries and others. This article highlights aspects of Edward H. Angle's life and persona, based on new findings culled from his letters and other personal documents.

Keywords: Edward H Angle, Orthodontics, History, Anna Hopkins

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Introduction

Edward Hartley Angle is one of the most dominant, dynamic and influential figure in speciality of Orthodontics. He was a fiercely determined young man of no remarkable heritage serendipitously finding his considerable aptitudes and blazing trails in pursuit of his visionary goals. Samuel L Clemens (Mark Twain), poet-story teller James Whitcomb Riley, Benjamin Franklin were among his famous heroes. All were creative achievers and resolute individualists of humble birth and with great connection to everyday people.

Edward Hartley Angle was born on June 1st 1855. He was recorded in the 1860 Bradford County census book as "Hartly" son of Philip Casebeer Angle and Isabel Erskine Angle. From his childhood he was called "Hart" by his family and close friends. Hart showed no enthusiasm in school or on the farm. He was always behind in his learning, especially mathematics. He was a natural tinkerer, a whittler, a marker of things. When his father needed a more efficient hay rake, 11 year old Hart invented one. However he did not get much appreciation for the new machine and soon someone else applied for and was awarded patent for his instinctively clever work.

In 1874, at the age of 18, Edward H Angle was introduced to dentistry with coaxing from his understanding mother Isabel. Recognizing his nascent mechanical skills, she secured a position for Hart with a dentist in nearby, as an office apprentice.

Two years later he applied to dental colleges. His scratchy, brief letter of inquiry dated September 6, 1876, to the Baltimore Dental College is the earliest document extant from his hand. He was invited to enroll at Pennsylvania College of Dental Surgery in Philadelphia for their DDS program. In 1895, Angle completed his MD degree from Marion Sims College.

Fig 1: Angle1881-1883 (26-28 years)

Angle's Dental Practice at Towanda

After dental school graduation in 1878, Edward Angle went to the Bradford County seat, Towanda, and set up a general dental practice of mechanical dentistry in the center of the town. Angle developed his first interests in mechanisms for tooth alignment or "regulation" considering the main purpose for moving teeth at that time.

After three years of dental practice in Towanda,26-year-old Dr. Angle abandoned dentistry and took a train to Minneapolis, Minnesota, on a physician's advice, in search of better health. For his health's sake, Angle was considering permanent retirement from dentistry in favor of work that was less confining and more outdoors.

Angle invested all his savings into their sheep-farming venture, all to be undone by the great blizzard of 1882, a record-breaking deep freeze that killed off the entire herd. A defeated Angle, feeling physically better but mentally depleted, hobbled in to Minneapolis by mid-1882 looking for work-again in dentistry.

He got back into general dental practice and soon resumed the creative thinking and tinkering with tooth regulating appliances that he began in Towanda. In 1886, 31- year old Angle was appointed as Professor of Histology and Lecturer on Comparative Anatomy and Orthodontia. A few years later, after the college merged into the University of Minnesota, he was elevated to the Professor of Orthodontia, a rare position in those days, when Orthodontia was an unexplored part of dentistry. His big break came in 1887 when Angle was permitted on the speaking program of Ninth International Medical Congress convened in Washington.

Edward Angle presented his talk entitled "Notes on Orthodontia with a New System of Regulation and Retention" using lantern slides, a relatively new visual aid for lecturing. He demonstrated his classification of tooth movements and his novel orthodontic devices, such as piano wire in a soldered pipe and the jack screw and traction screw. Many well-known dentists in the audience accused Angle of falsely claiming

originality. The edited paper and subsequent inflammatory discussions were published in the Transactions of the Ninth International Medical Congress under an imposed, truncated, non-controversial title "Notes on Orthodontia". This 1887 article commonly has been called the "First Edition" of his classic textbook on the treatment of malocclusion.

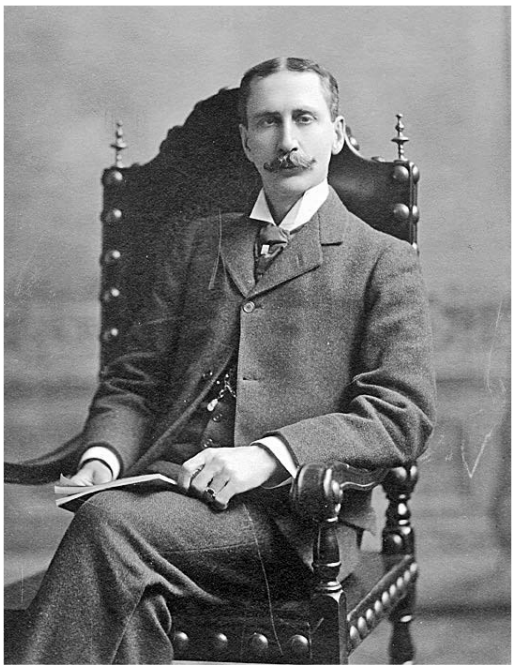

Fig 2: Edward Hartley Angle, age 43 years, 1898, St Louis, Missouri, at the beginning of his legendary ascent in international fame and fortune.

The year 1892 was a watershed in Angle's professional development. He announced that he would be practicing Orthodontia to the exclusion of all other dental therapies. With this decision, he became the first acknowledged exclusive specialist in Orthodontics in the world. Edward H Angle resigned from University of Minnesota and concentrated his energies on experimentation in Orthodontia and the development of marketable prefabricated new treatment appliances.

E. H Angle's School of Orthodontics

In 1900, Angle founded the first postgraduate school of Orthodontics, Angle school of Orthodontia. He also founded the first Orthodontic journal, The American Orthodontist in 1907, but could not prolong its publication beyond 1912. Prior to admission, student was thoroughly grilled in the basic sciences, either by Dr. Angle or one of his staff. The applicant was expected to know the anatomy, embryology and histology of the head and neck, the growth, development, and functioning of the denture. He also expected the applicant to be reasonably familiar with history, general science and English literature. Only after surviving the rigors of discipline, theory, technique and cast analysis, the student was allowed admission to the clinic.

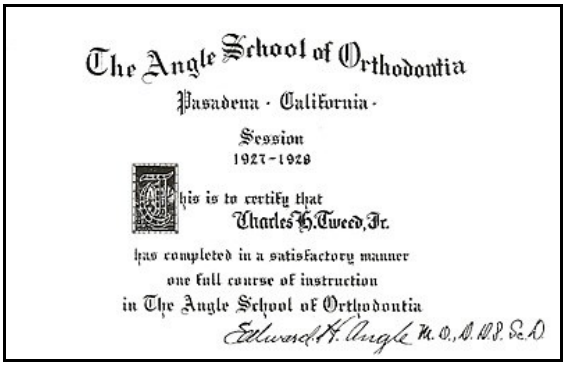
The Angle School of Orthodontia
Pasadena · California ·
Session
1927-1928
This is to certify that
Charles H. Tweed, Jr.
has completed in a satisfactory manner
one full course of instruction
in The Angle School of Orthodontia
Edward H. Angle M.D., D.M.D., Sc.D.

Fig 3: Certificate issued to Dr. Charles Tweed , a student at the Angle School of Orthodontia

In 1922, the members of Angle's school founded a formal association: The Edward H Angle Society of Orthodontia (commonly called Angle Society). The meeting of this society in New London was the last meeting that Angle ever attended. In 1927 The Angle College of Orthodontia closed unofficially due to Angle's deteriorating health.

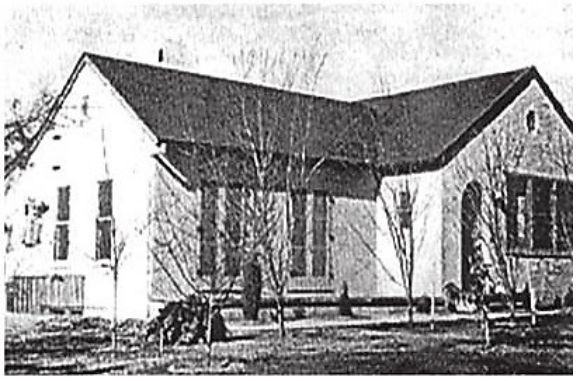

Fig 4: The Angle School of Orthodontia

About Anna Hopkins

About 1908, Angle married his longtime secretary, Anna Hopkins, who had obtained her DDS degree from the University of Iowa and her Orthodontic training in his school. "Mother Angle" became Secretary of the American Society of Orthodontics, a founding Co-Editor of the Angle Orthodontist, and honorary chair of the Angle Society executive committee, but she should be best remembered as Angle's amanuensis, editor, foil and buffer for many of his downtrodden students.

Fig 5: Anna Hopkins –"Mother Angle"

In August 11, 1930 Edward H. Angle died in Santa Monica, California, at age 75 from heart failure and was buried at Mountain View Cemetery, Altadena, California. In 1932, two years after Angle's death, she submitted a solicited biographical sketch of her famous husband for The National Cyclopaedia of American Biography. In addition to the requisite dates, places and happenings, she inserted three defining sentences that probably reflected how the Angles wished Edward Hartley Angle would be remembered. Her earnest words, understandably hagiographic, still express one of the most fitting tributes we may bestow on this extraordinary prime mover in the evolution of orthodontics:

"*Dr.Angle was a thinker of vision and imagination and a lover of the beautiful in character, art, and nature. He was fond of children, literature, and outdoor life. He lived and worked intensely and gave always the best his mind and hand could evolve to advance the profession of which he was the founder and leader.*"

Appliance Contributions by Edward H Angle

Edward H Angle's correspondence and patents reveal features of the most dynamic side perhaps of this multidimensional man: the rapt and consummate inventor, a human wellspring of new ideas. During his lifetime, Angle applied for and received 45 patents (his wife Anna Hopkins obtained his 46th patent in 1934, four years after his death). Most were appliances and instruments related to clinical

Orthodontics, but they included laboratory equipment and a novel automobile wheel.

Edward H Angle's rationale for patenting his inventions was to take legal claim of his ideas and to protect his business interests. However, many of Angles colleagues criticized him for the zeal with which he protected his breakthrough appliances and systems for doing "tooth regulation" and "orthodontia" more easily. Patent protection certainly makes sense in today's high-stakes environment of corporate espionage and intellectual property rights, but in Angle's time, patenting-particularly in medicine-was viewed in many circles as selfish and mercenary.

Angle's patented Orthodontic device, first patent in 1889 is push type jackscrew which was used to increase the width of the arches thereby treating the malocclusions. In 1851, a lingual arch soldered to bands that are soldered to bands that are cemented on teeth; forcing teeth "outward and forward". Special pliers pinched the wire increasing its length.

E Arch Appliance

E-arch appliance was developed by Angle in early 1900. It was the first Angle's orthodontic appliance developed to treat malocclusions. Arch appliance consists of bands which are placed on molar teeth on either side of the arch of a heavy labial arch wire extended around the arch. The ends of labial extended arch wire threaded to the buccal aspects of the molar bands allowed the arch wire to be advanced so that the arch perimeter increased.

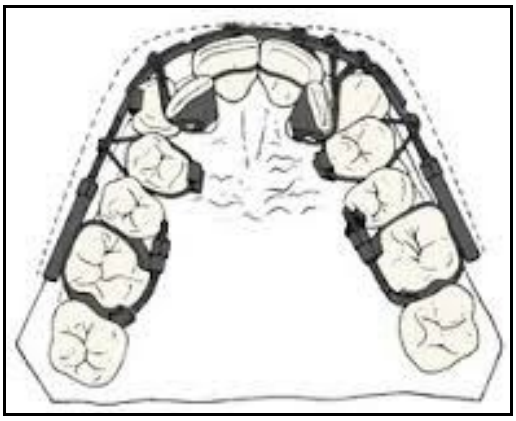

Fig 6: E Arch Appliance

Pin and Tube Appliance

Pin and tube appliance was also developed by E.H Angle. In this appliance all teeth were banded. Vertical tubes were welded to the bands on the labial surface in the center of crown for all teeth in the arch. Arch wires were secured with soldered pins that inserted into the vertical tubes. Tooth movement was achieved by altering the position of the pins.

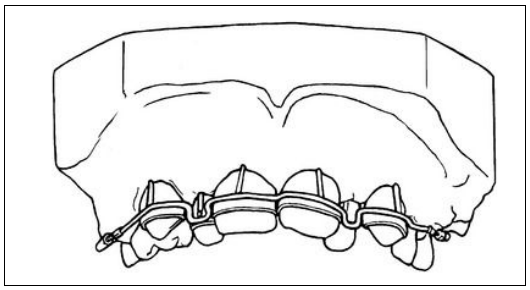

Fig 7: Pin and Tube Appliance

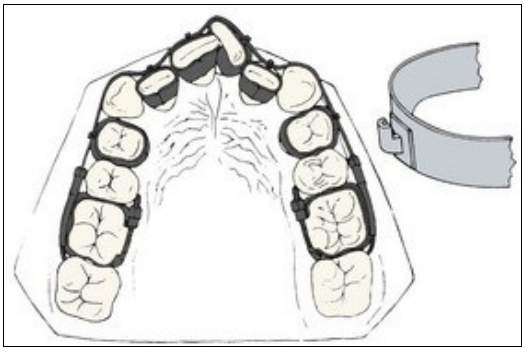

Fig 8: Ribbon Arch Appliance

Ribbon Arch Appliance

It is the modification of pin and tube appliance. Ribbon arch was the first appliance to use a true bracket. The bracket has a vertical slot facing occlusally. The brackets were attached to the bands.

Edgewise Appliance

The edge wise bracket has a rectangular slot facing labially rather than occlusally or gingivally, which receives a rectangular arch wire. This unique feature of rectangular arch wire in a rectangular slot enabled control of tooth movement in all three planes of space.

Angle's Orthodontic Material Invention

Angle made an inventory of the available materials-gold, silver, platinum, iridio-platinum, aluminum, brass, copper, steel, iron and vulcanized rubber. He found that "the material most fitting was nickel silver", a brass that did not have any silver in it at all. He was largely self-taught and yet he mastered complex metallurgy. His knowledge of noble metals is witnessed also by his use of gold and of platinum-iridium arches in orthodontics. He was the first to use coil springs.

Calvin - Angle Controversy

Originally, Calvin Case was a genuine admirer of Angle. In fact he gave up the general practice of dentistry because of Angle's influence. The discord between Angle and Case started over the claim that Angle attributed the origin of the use of inter maxillary elastics to Baker, while Case thought that he should have received that credit. This lead to charges and counter charges between them in 1903.

Fig 9: Calvin Case

Also, Angle's propagated that "there shall be a full complement of teeth and that each tooth shall be made to occupy its normal position". This was a non extraction correction protocol. Case defended this by the discreet use of extraction as a practical procedure which enhanced the facial profile of several subjects, in whom Angle's non-extraction correction did not result in esthetically pleasing profiles.

Conclusion

Though Angle died in 1930 his influence is still felt strongly in Orthodontics. His pioneer efforts in Orthodontic education, his contribution to Orthodontic literature, and his developments of innumerable instruments and appliances are not the accomplishment for which he will be remembered. Angles name will be associated with the onward march of biologic science and it will be realized how perspective was the mind that could penetrate the empiricism of his day and proclaim the significance of normal

occlusion. Characteristic of a man was a remark made shortly before he died: **"*I have finished my work. It is as perfect as I can make it*."**

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ENDODONTIC MANAGEMENT OF MIDDLE MESIAL CANAL IN MANDIBULAR MOLAR: A CASE REPORT

*Dr. Elsy Bijoy

Abstract

Root canal treatment of a tooth with aberrant canals can be diagnostically and technically challenging. One of the earliest permanent tooth to erupt into the oral cavity is the mandibular first molars. Therefore, it is one of the most common tooth involved in endodontic therapy. Various case reports and studies show that the mandibular molars have a predilection to canal variation. This case report presents the endodontic management of a mandibular molar with an extra canal in the mesial root known as the middle mesial canal.

Keywords: Middle mesial canal, mandibular molar, root canal anatomy

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Introduction

"Of all the phases of anatomical study in the human system, one of the most complex is the pulp cavity morphology"

– M T Barrett

Numerous research and case presentations have clearly established that the hard tissue repository of the dental pulp takes on numerous configurations and shape and a root with a tapering canal and single foramen is the exception rather than the rule. Knowledge of the normal anatomy of the root canal system and the variations that may arise dictate the parameters for root canal therapy and may affect the final outcome of the treatment. Missed extra roots or root canals are a common cause of failure in root canal therapy.[1]

Traditionally, the mandibular molars are described as having two roots with two canals in the mesial root and one or two canals in the distal root. However, anatomical variations in the root canal morphology of mandibular molars have been vastly reported and many authors report a correlation of the variations to race and genetics. These variations reported include, C-shaped roots and/canals, isthmus between the mesio-buccal (MB) and mesio- lingual (ML) root ,five, six and even seven canals, radix entomolaris and a third canal in the mesial root called as the middle mesial canal (MM).[2-4]

The prevalence of the middle mesial canals reported varies from 0-36% depending on the type of study methodology employed.[5-7] The canal is also known as the "intermediary mesial canal" or medial mesial canal. It's located centrally between the buccal and lingual root canals. Its diameter is less than the other two canals. Pomeranz et al[2] described the anatomy of MM canals as 1) fin: The file passes freely between the main mesial canal (ML or MB)

and the MM canal (transverse anatomies), 2) Confluent: The MM canal originates as a separate orifice but apically joins the MB or ML canal and 3) Independent: The MM canal originates as a separate orifice and terminates as a separate apical foramen.

The aim of this article is to presents the endodontic management of a mandibular first molar with confluent middle mesial canal and review the literature.

Case report

A 40 year old male patient reported to the Department of Conservative Dentistry and Endodontics with pain in relation to tooth number 37. Oral examination revealed a deep carious lesion involving the occlusal surface. IOPA X ray showed caries involving pulp. Vitality tests gave a delayed response. A diagnosis of chronic pulpitis was made.

The tooth was anesthetized with inferior alveolar nerve block (IANB) and isolated using rubber dam. Caries excavation and de roofing of the pulp chamber was done using #3 Endo access bur (Dentsply, USA). The pulp was extirpated and the pulp chamber flushed with 2.5% sodium hypochlorite. The three main canals distal, mesiobuccal and mesiolingual were first located and patency ascertained with # 10 K file. Coronal enlargement was done using Sx rotary file (Dentsply, USA).Working length was electronically assessed using an apex locator (Root ZX,J Morita, Japan) up to 20mm. The cleaning and shaping was completed upto Protaper rotary file F2 (Dentsply, USA).Complete removal of the cervical ledge in the mesial side was done carefully using Gates-Glidden drill # 3.The middle mesial canal was then located between the mesio buccal and mesio lingual canal and found to lie closer to the mesio lingual canal(Fig 1).

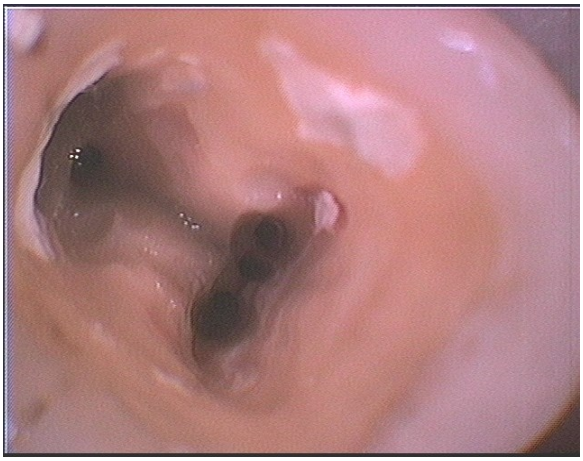

Fig 1: Middle mesial canal found closer to the mesio lingual canal

The canal patency was ascertained and its working length assessed .It was found to fuse with mesiolingual apically. Cleaning and shaping of the middle mesial canal was completed upto Protaper rotary file F1(Dentsply,USA).The distal canal was enlarged upto Protaper F3.The instrumentation was done using EDTA (Glyde,Dentsply,USA) as a lubricant and to ensure removal of smear layer.The canals were given a final flush with saline before drying with paper points.Master cones were placed in position within the canals and a radiograpg was taken (Fig2). Canal obturation was done using single cone technique and AH- plus sealer (Dentsply,USA).The access was restored with silver amalgam(Fig 3).

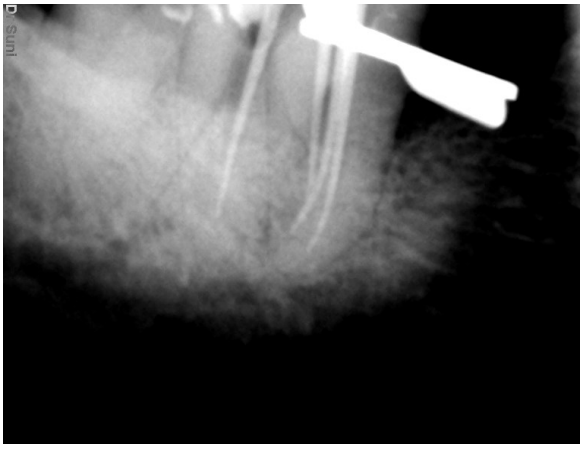

Fig 2: IOPA Xray shows 37 with master cones

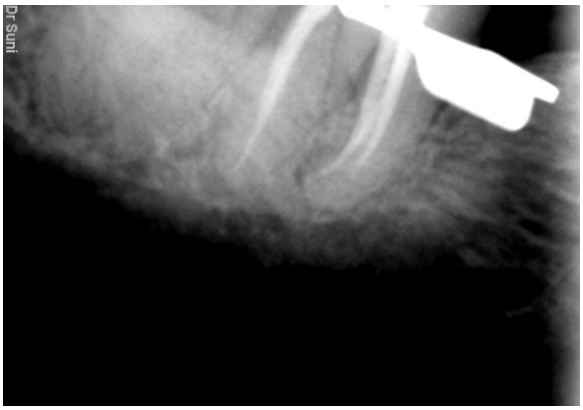

Fig 3: post obturation IOPA Xray

Discussion

Post endodontic treatment failure may be attributed to the presence of bacterial biofilm persisting in the root canal ramifications such as fins delta, loops, accessory canals and isthmuses.[7] Unusual canal associated with mandibular molars have been reported in several studies. Vertucci and Williams in 1974 first reported the presence of a middle mesial (MM) canal in a mandibular molar.[1] In 1989 Fabra et al studied 145 teeth in vivo and reported 2.1% incidence of MM in mandibular molars.1.7% of the third canal joined the mesiobuccal canal in the apical third and 1.6% converged with the mesiolingual canal and as an independent canal 0.13% .[3,7] Goel et al reported that mandibular first molars had three mesial canals in 13.3% ,four mesial canals in 3.3% in a clinical evaluation of 100 madibular molars.[8] Ali Nosrat et al reported a higher incidence of negotiable MM canals in younger patients. Patients aged 20 years or younger showed an incidence of 32.1% for negotiable MM canals in mandibular molars. He also reported 29.4% incidence amongst blacks and Hispanics against 12.2% seen among the white population.[7] Pomeranz et al [2] studied and found 12% molars with MM canals in their mesial roots and classified them into three morphological categories as: fin, confluent and independent. He also reported that the MM orifice was always located closer to ML canal. A similar finding was reported by Nousrat et al. An independent anatomies is considered rare. According to Pomeranz the most prevalent anatomy was a fin (67%).Karapinar-Kazandag et al reported a confluent anatomy in all the MM cases. Ali Nousrat also reported a higher incidence of confluent anatomy with 46.7%. [2,7]

The case presented in this report was also of the confluent type showing separate orifices. The MM canal orifice was found closer to mesiolingual orifice and joined the mesiolingual canal apically.

Though conventional radiographs have its limitations, a good pre operative radiograph can sometimes disclose the presence of an extra canal or root. Radiographs taken in two different horizontal angulations can reveal extra canals. The efficacy of CBCT imaging in locating root and canal variations has been reported through various clinical reports and studies. The use of magnification in

Endodontics is also well established. Nosrat reported a 20% incidence of MM in his study in contrast to the 12% reported by Pomeranz, and he attributed this to the use of dental operating microscope in his study.[2,7] Ensuring a proper access cavity preparation is necessary in detecting and treating extra canals. Other techniques can be utilized to help detect extra canals such as, careful examination of the sub pulpal floor with a sharp probe ,preferable using loupes or microscope, troughing of grooves with ultrasonic tips, use of 1% methylene blue dye to stain the chamber floor, champagne bubble test, fiberoptic transillumination and visualization of bleeding points.[7-10]

Conclusion

Whilst performing root canal treatment an Endodontist has to be prepared to expect the unexpected. Procedural complications and treatment failure can be avoided to an extend if the operator is well versed in the normal anatomy of each tooth and the possible variations that can arise, its predilection to certain teeth and the changes in the morphology seen with age. However, better diagnostic techniques, magnification illumination and procedural techniques have raised the quality of endodontic therapy and the success rate.

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