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DENTAL BITES

Volume 10 Issue 1 | January - March 2023

Restorative and Reconstructive Dentistry

a quarterly publication of KMCT DENTAL COLLEGE
Recognized Research Centre of KUHS

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Editorial Board

Dear Readers,

With immense pride and enthusiasm, I present the latest edition of our college research journal. This publication stands as a testament to the unwavering commitment of our academic community to the pursuit of knowledge and innovation. Innovation is the lifeblood of progress, and it is deeply ingrained in the ethos of our institution.

In today's rapidly changing world, the ability to innovate is more critical than ever. Our students and faculty have risen to the occasion, consistently pushing the boundaries of what is known and charting new territories in their respective fields. From groundbreaking research in science and technology to transformative insights in the humanities and social sciences, this journal reflects the rich tapestry of intellectual exploration happening within our college.

Innovation is not merely about creating something new; it is about making a meaningful impact on society. As you peruse the pages of this journal, you will encounter studies and projects that have the potential to reshape industries, improve lives, and tackle pressing global challenges.

I want to express my profound appreciation to our students and faculty for their dedication, creativity, and tireless efforts in advancing the frontiers of knowledge. I also extend my gratitude to our readers and supporters for your unwavering encouragement and interest in our research endeavours.

In conclusion, I believe that innovation is not a destination but a journey. As we continue this journey, let us remain committed to fostering a culture of innovation that empowers the next generation of thinkers and problem solvers. Together, we will shape a brighter future for our college, our community, and the world at large.

With warm regards,

Dr Manoj Kumar K.P

Principal

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Short Communication

DENTAL EDUCATION FOR GENERATION Z

Do we need a new strategy?

*Elsy P Simon

Abstract

The educators must consider that Gen-Z learns in a different way and has a unique and different vision of the world than the previous generation. They need to consider the constant use of technology, effective communication and feedback techniques, in addition to the implementation of educational methods that promote creativity and well-being[2].

**Professor and Head, Department of Conservative Dentistry and Endodontics, KMCT Dental College, Manassery, Kozhikode, Kerala.*

Introduction

Generation Z is a cohort with members born between 1996 and 2012. The majority of students who are currently studying or finishing University belong to the so-called "Generation Z", their ages ranging between the age of 18 and 27 years.[1] August Comte have argued that generational change is what drives social changes. More specifically, each generation entering into a new life stage at more or less the same time is the pulse that creates the history of a society.[2]

The first Gen Zers were born when the internet had just achieved widespread use. They are thus called “Digital Natives”. With 24×7 access through their mobile phones, the digital world has revolutionized every part of life, including learning, socializing, shopping and entertainment. Shifting political, economical, and social landscape locally and globally; climate crisis and Covid 19 has also impacted the formative stages of this generation.[1]

Today's dental students, Generation Z (Gen Z), are said to learn differently than those of previous generations. As generations of dental students vary, our teaching styles must keep up with unique and changing groups of individuals. Their mentoring should enhance the strengths while providing support to control the negative attributes of the cohort.[2]

Perspectives about Gen Z

This generation is considered to be inspired to change their world as they have been involved in various unfortunate global situations in their lifetime. The chaos and disorder they perceive in governments motivate them to get involved and make a difference in their environment.[2] Pertaining to education or learning, Gen- Z is reevaluating the cost/benefit analysis of traditional education given the dramatic rise in education expenses and the impact of student loan debts. Monetarily, they would prioritize financial security over "personal fulfillment"[3].

Some positive attributes that have described Generation Z, that should be considered in educational processes are:[2,4]

1.They are "Digital natives". Students would choose to work independently via online platforms and tutorials.

2.Acceptance to diversity in terms of race, gender and sexual orientation.

3.Pragmatic in their outlook.

4.Priortize social activism.

5.Search for a positive impact in the world.

6.Value responsibility, ethics and independence.

7. Seek opportunities to enhance skills

On the other hand, some negative characteristics have been mentioned about this new generation, such as a low level of emotional resilience or self-confidence, which leads to insecurity and a high degree of psychological stress. In addition, cases of depression, anxiety, self-harm and suicidal thoughts have been reported from an early age in its members. They also tend to prefer individual tasks over team work.[2,4]

Knowing and understanding the motivations, abilities and expectations of the new generations of students in health careers is of great interest to educators and admission committees, since each cohort is unique and individuals express their social and emotional dynamics in different ways.[4]

The Educators Role

Generation Z is considered the most diverse so far and requires closer mentoring from teachers, who must be ready to help the students to make better use of time and resources.

With regard to dental education, the current scenario is an inter-generational synergy, where veteran teachers belong to the Baby Boomer Generation, some other teachers are part of Generations X and Y, and current students conform Gen Z. This situation requires a progressive adaptation for the teachers, which represents a considerable challenge to the academic community. The questioning is directed to knowing if the faculty is prepared with educational resources for the new generation.

The educators must consider that Gen-Z learns in a different way and has a unique and different vision of the world than the previous generation. They need to consider the constant use of technology, effective communication and feedback techniques, in addition to the implementation of educational methods that promote creativity and well-being[2]. For this new generation, it will be necessary for the educator to learn new skills.

Adapting dental curriculum to include technological advances.

In the past 15-20 years, dentistry has experienced a revolution digitally, technologically and in material sciences. This has resulted in mushrooming skill development educators that claim to train specific skill sets for general dental practice. This has gained immense popularity among the Gen Z graduates in the face of rising cost of post graduate education. The outcome of these short term courses that do not fall under any screening body may be questionable. Providing opportunities to learn and train with new technology during the under graduate and post graduate programs will help the graduates in educated decision making, that elevates them professionally.

Research and entrepreneurship is a road less travelled by dental schools in India. It's a field that opens hidden opportunities for young inquisitive minds. Dental schools are slowly tapping into this lucrative area. However, it comes with its own challenges such as requiring the presence of more supporting staff and facilities which would increase the cost of dental education further.

Some cutting-edge advances if included in dental education would turn learning into an enjoyable experience[5].

Virtual and augmented reality training[5]

One of the most significant advancements in dental education is the use of virtual and augmented reality (VD/VR). The training provide a unique learning experience and have shown to boost confidence and skill for real life experiances.

3D Printing[5]

The integration of 3 D printing in dental education will be a game changer. Accurate models of teeth for training and customized appliances, implants and restorations may be created by the students. It may also be used to support enterprising ideas to develop entrepreneurial skills among the students.

Artificial intelligence(AI)[6]

The full potential of AI in dental training is still untapped. Some possible examples of the use of AI in dentistry, some of which are under research, include:

1.The use of machine learning algorithms to automate the interpretation of dental imaging procedures, such as radiographs and CT scans, which have been studied since the 1980s.

2.The development of AI-powered tools to automatically detect dental caries and other oral diseases has been an active area of research since the 1990s.

3.The use of AI to support dental diagnosis and treatment planning, which has been explored more recently and is still in the early stages of development.

Some potential changes that could result from the use of AI in dentistry include the following:

1.A shift toward more evidence-based, data-driven dental diagnosis and treatment planning approaches.

2.The use of digital diagnostic technologies, such as 3D imaging and machine learning algorithms, is greater in dental education.

3.More emphasis is on training dental students to use and interpret AI-based diagnostic tools.

4.The development of new educational resources and curricula that address AI and its applications in dentistry.

5.Integrating AI-powered tools into dental simulations and other hands-on activities for dental students.

The challenges to progress

Integrating new technology to current dental education comes with its pros and cons. Primarily,the infrastructure has to be re-designed to include new high tech equipment.The installation and maintenance will require skilled staff that would add to the overhead cost. Secondly, the educators have to be trained which may be time consuming and costly too. Regardless, the potential benefits of embracing new technology into routine health care education and health care provision can be deemed to be far greater than the obstacles.

Conclusion

Dental education in India is poised for a shift.In fact, the wheels of change has already been initiated by some dental schools to provide education at par to international standards. For a generation that are born into a technologically enriched environment, yet unique in the circumstances they are molded; the educator has to be a student first learning new skills to best train the students. Institutions and universities should facilitate in the enrichment of the faculty and equip them with key skills to train the future educators and practitioners of dentistry.

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Original research

COMPARATIVE ANALYSIS OF THE SEALING ABILITY OF MINERAL TRIOXIDE PLUS AND BIODENTINE AS ROOT END FILLING MATERIALS – AN INVITRO STUDY

*Subin Bharath **Ragina S.J *** Elsy P Simon ****Sarin K

**** Nevil Mathews ****Veena M.V

Abstract

Background and Aim: To compare the sealing ability of Mineral Trioxide Aggregate plus and Biodentine as root end filling materials in extracted natural teeth

Material and Methods: Forty premolars were used in this experimental study. Root canal treatment was done in each tooth and obturation was done with gutta percha and zical sealer. Access restored with type 2 glass ionomer cement. Root resection was done and 3mm class 1 cavity was prepared apically using ultrasonic retro tip. It was divided in to 2 groups. Samples in Group 1 was filled with MTA plus and Samples in Group 2 was filled with biodentine. Specimens were contaminated with fresh blood without anticoagulant to mimic the oral surgical field. Specimens were suspended in 1 percentage of methylene blue for 24 hours. Then the specimens were sectioned and were observed under optical microscope and length of dye penetration was assessed.

Results: The two groups (MTA plus group and biodentine group) did not differ statistically on the sealing ability as a root end filling material.

Statistical Analysis: Independent t test was used.

Conclusion: Within the limitations of this study no significant difference was noted in the sealing ability between MTA plus and Biodentine as root end filling material.

***Key words**: MTA plus , Biodentine , Root end filling material*

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Introduction

The goal of an ideal endodontic therapy is to hermetically seal all pathways of communication between the pulp and periodontium. Apical seal obtained by obturation and coronal seal obtained by post endodontic restoration prevent the percolation of any oral fluids thus preventing the recontamination of the root canals.[1] A non-healing or a persistent periapical lesion shows a failure of orthograde root canal therapy or nonsurgical endodontics. These cases are best treated by apicectomy followed by root-end restoration.[2] The main objective of a root-end restoration is to provide a seal that prevents the leakage of microorganisms from the pulp to periapical tissues and vice versa. Apical seal is the crucial factor for the success of surgical endodontics.[3] An ideal root end filling material should be impervious to moisture, antibacterial, nontoxic, non-resorbable, easy to manipulate, biocompatible, provide good seal and promote regeneration of the periodontal apparatus. It should form a tight seal in the root canal by adhering with the cavity walls.[4]

Materials and Methodology

Forty premolars were used in this experimental study. The premolars were decoronated. Root canal treatment was done in each tooth. Biomechanical preparation done using edge endo to size 6 percentage 30. Copious irrigation was done 3 percentage sodium hypochlorite saline and EDTA. Obturation done with gutta percha and zical sealer

Access restored with type 2 glass ionomer cement (3M KETAC MOLAR). Resection of each sample at 90 degrees to the long axis of the tooth was done. 3mm class 1 cavity was prepared apically using ultrasonic retro tip. Samples were divided in to 2 groups. Samples in Group 1 was filled with MTA plus and Samples in Group

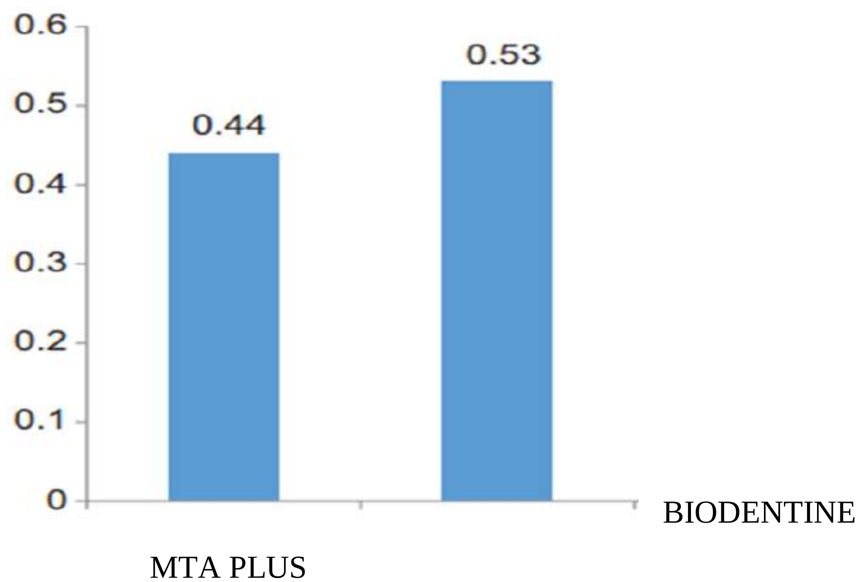
2 was filled with biodentine. Specimens were contaminated with fresh blood without anticoagulant to mimic the oral surgical field. Specimens were suspended in 1 percentage of methylene blue for 24 hours. Then the specimens were sectioned and were observed under optical microscope and length of dye penetration was assessed.

Group A (MTA plus) – 20 teeth

Group B (Biodentine) – 20 teeth

Statistical analysis

Statistical software IBM SPSS statistics 20.0 (IBM Corporation, Armonk, NY, USA) was used for the analyses of the data. Independent t test was used to find the significance of study parameters between the groups. $p<0.05$ and any value less than or equal to 0.05 was considered to be statistically significant.



Dye penetration was noted more in MTA PLUS than in BIODENTINE. But the difference was not statistically significant.

Discussion

Root end filling is the procedure in which biocompatible materials filled into the retrograde cavity.[5] There are many materials used in the past like amalgam, GIC, Gutta-percha, IRM to provide a good seal. However, an ideal retrograde filling material fulfilling all the ideal requirements such as biocompatibility, adherence to the prepared walls and formation of a fluid tight seal in the root canal system is difficult to achieve.[4] In old times amalgam was considered the material of choice for root end filling. In recent times MTA has been developed which fulfils almost all the requirements of an ideal root end filling material and has become the gold standard against which the newer materials are compared.

Since achieving a dry field is not always possible, the study design was aimed at evaluating the sealing ability of test material (MTA plus and Biodentine) in blood-contaminated field which is usually the clinical scenario.

Bioceramic root-end filling materials have given promising results as compared to traditional materials. Biodentine is calcium silicate-based cement that can be used for dentin replacement as it is bioactive, biocompatible and has excellent sealing properties. Biodentine is similar to MTA in composition. MTA Plus is a new material with a composition similar to MTA Angelus. The particle size is much smaller and fine in MTA plus as suggested by the manufacturer. MTA Plus comes with a pre-measured water ampule for mixing. MTA plus manufacturers claim that these materials have good handling properties and biological properties which makes it suitable for root-end filling.

The results of our study showed that the microleakage was lower for Biodentine than MTA plus. The reason could be a shorter setting time (12 min), hydrophilicity and mild setting expansion.. The faster a material sets the lesser chances of partial material loss.

Another important determining factor is the pore diameter and volume. The larger the pore diameter, the larger the leakage along with the interface, thereby resulting in poor fluid seal. Water: powder ratio also greatly influences the pore diameter. The greater the water: powder ratio the larger the pore diameter. Since MTA plus is to be mixed manually there are many chances of deviation from ideal w:P ratio. On the other hand, Biodentine is available in a predosed formulation with a lower W:P ratio, resulting in a smaller pore size than MTA plus.[6,7,8] The decreased pore volume and porosity of biodentine as compared to MTA plus may contribute to better sealing.[9]

Conclusion

Within the limitations of this study no significant difference was noted in the sealing ability between MTA plus and Biodentine as root end filling material.

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Original research

A FINITE ELEMENT ANALYSIS ON THE EFFECT OF FIBRE POST ON STRESS DISTRIBUTION IN ENDODONTICALLY TREATED MAXILLARY FIRST PREMOLAR

*Nevil Mathews **Vidya V*** Ravi SV****Subin Bharath

****Chandini Raveendran *Veena MV

Abstract

Context: The restoration of endodontically treated teeth has changed in recent years. The availability of adhesive techniques has increased the clinician's repertoire in terms of restoring teeth.

Aim: By means of a finite element method (FEM), the present study is to evaluate the effect of fiber post (FP) placement on the stress distribution in endodontically treated upper first premolars (UFPs) with mesial–occlusal–distal (MOD) composite restorations under static load.

Materials and Methods: FEM models are created to simulate three different clinical situations involving endodontically treated upper first premolars with MOD cavities restored with one of the following: composite resin, one fibre post in the palatal root and two fibre post – one in palatal and buccal root. As control, the model of an intact upper first premolar was included. A simulated load of 150 N is applied. Stress distribution is observed on each model surface, on the mid buccal– palatal plane and on two horizontal planes (at cervical and root-furcation levels); the maximum Von Mises stress values are calculated.

Results: Most favourable stress distribution was found in the intact tooth model and among experimental models, stress concentration was found to be the least in the cervical and furcation area in the model restored with fibre post in both buccal and palatal root

Conclusion: The maximum stresses were concentrated at the occlusal interfaces between the tooth and composite, which indicates those areas to be critical for fractures originating from the coronal portion of the tooth

Key words: *Fiber post, Finite element analysis, Maxillary premolar*

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Introduction

Endodontically treated teeth are structurally different from non-restored vital teeth. The differences include changes in the amount of the tooth structure, in the properties of dentine, and in proprioception. For these reasons, they require specific restorative treatments.[3] The retention of restorative materials, in cases with substantial coronal dentine loss, can be enhanced by an endodontic post with the aim of improving the longevity of the restoration.

Owing to the specific morphology and position in the tooth arch, premolars are subjected to higher masticatory loads than frontal teeth, but they are also more likely than molars to be subjected to lateral forces during mastication. Compared to molars, premolars have less tooth substance and smaller pulp chambers to retain a core build-up after endodontic treatment.[1] Moreover, the preparation of an endodontic access cavity increases the possibility of cusp fractures following the cusp deflection during function, which is higher for endodontically treated premolars with MOD preparations and the stress distribution within the root of tooth play a key role in the full understanding of the fracture resistance and crack propagation mechanisms along weakened tooth surfaces.

Aim of the study

To evaluate the effect of fibre post placement on stress distribution in an endodontically treated maxillary first premolar with mesio–occluso–distal composite restoration by the means of finite element analysis

Material and Method

An intact, sound, mature human maxillary first premolar was scanned in a high-resolution cone-beam computed tomographic machine (Planmeca ProMax 3d MID; Planmeca, Helsinki, Finland). The MOD cavities were standardized simulating a severe dental structure loss, with a dentine thickness of 2.1 mm and 2.5 mm remaining respectively on the buccal and on the palatal walls.

Finite element analysis studies represent biological material as isotropic, linear and elastic, hence the two parameters modulus of elasticity and poisson's ratio are taken for the study and the properties attributed to the isotropic materials included in the model are presented in Table 1

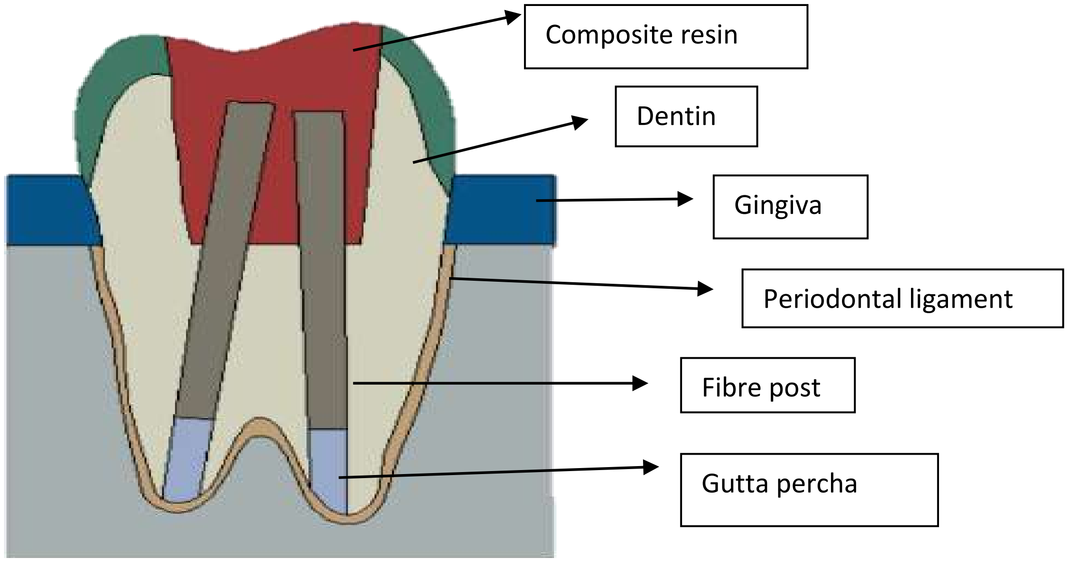
Table 1: Material properties used for the isotropic materials

Material	Modulus of elasticity	Poisson ratio
Enamel	84,100	0.33
Dentin	18,600	0.31
Gingiva	19.6	0.30
Periodontal ligament	67	0.47
Bone	14,000	0.30
Gutta percha	69	0.45
Pulp	2	0.45
Nanocomposite resin (Grandio)	12,770	0.31
Fibre post	E_X-9500 E_Y-37000 E_Z-9500	V_{XY}-0.27 V_{XZ}-0.27 V_{YZ}-0.34

Post Preparation – The size of the post used in the study corresponded to a commercially available fiber post (EnaPost CP0210: Micerium, Avegno, Italy) with 1 mm apical diameter and 2% taper. The post preparation size was standardized to 1.1mm. A 4 mm guttapercha apical seal was left to mimic standard and acceptable clinical conditions. The orthotropic properties employed for the fiber post have been deduced from previous papers and are listed in Table 2.

Table 2. Material constants of orthotropic fiber post.

Modulus of Elasticity (MPa)			Shear Modulus (MPa)			Poisson's Ratio		
E_x	E_y	E_z	G_{xy}	G_{xz}	G_{yz}	υ_{xy}	υ_{xz}	υ_{yz}
9500	37,000	9500	3100	3100	3500	0.27	0.27	0.34



Schematic representation of the tooth assembly

By using finite element modeling (FEM), 5 clinical situations were simulated and assigned to 1 control and 4 experimental groups. In the control group (Group 1), the tooth was maintained intact. The other four experimental groups simulated an endodontically treated tooth restored following the subsequent treatment modalities:

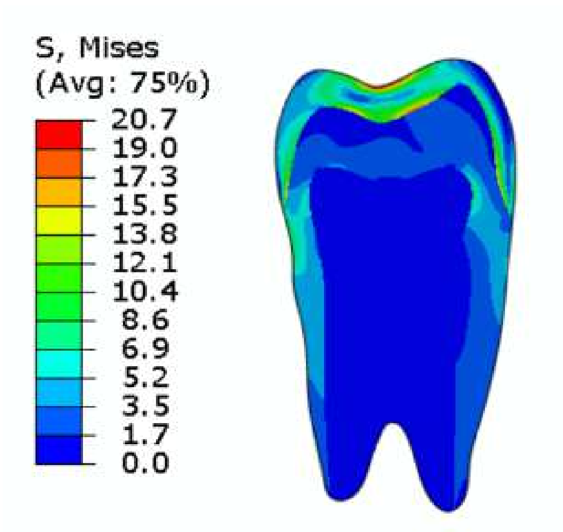
- Control group (Group 1): Intact tooth

  Four experimental groups
- Group 2: MOD nanocomposite restoration
- Group 3: One fiber post in the palatal root canal
- Group 4: One fiber post in the buccal root canal
- Group 5: Two fibre post; one in the palatal and buccal root respectively

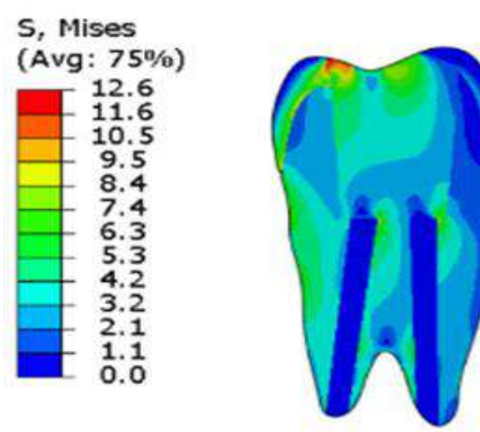
FEA modeling: The 2D planar model was exported to ABAQUS 2019 software to generate the definitive meshed premolar model. By using finite element modeling (FEM), 5 clinical situations were simulated with a total 38000 elements (element CPS4R)

All models were loaded applying 150 N static load to the triangular ridges of buccal and palatal cusps respectively at 25 and 22 degrees along the long axis of the tooth. Von Mises stress distributions maps, based on a linear static structural analysis, were calculated on the mid buccal– palatal plane and on two horizontal planes (at cervical and root-furcation levels)

Result:



GROUP 1



GROUP 2

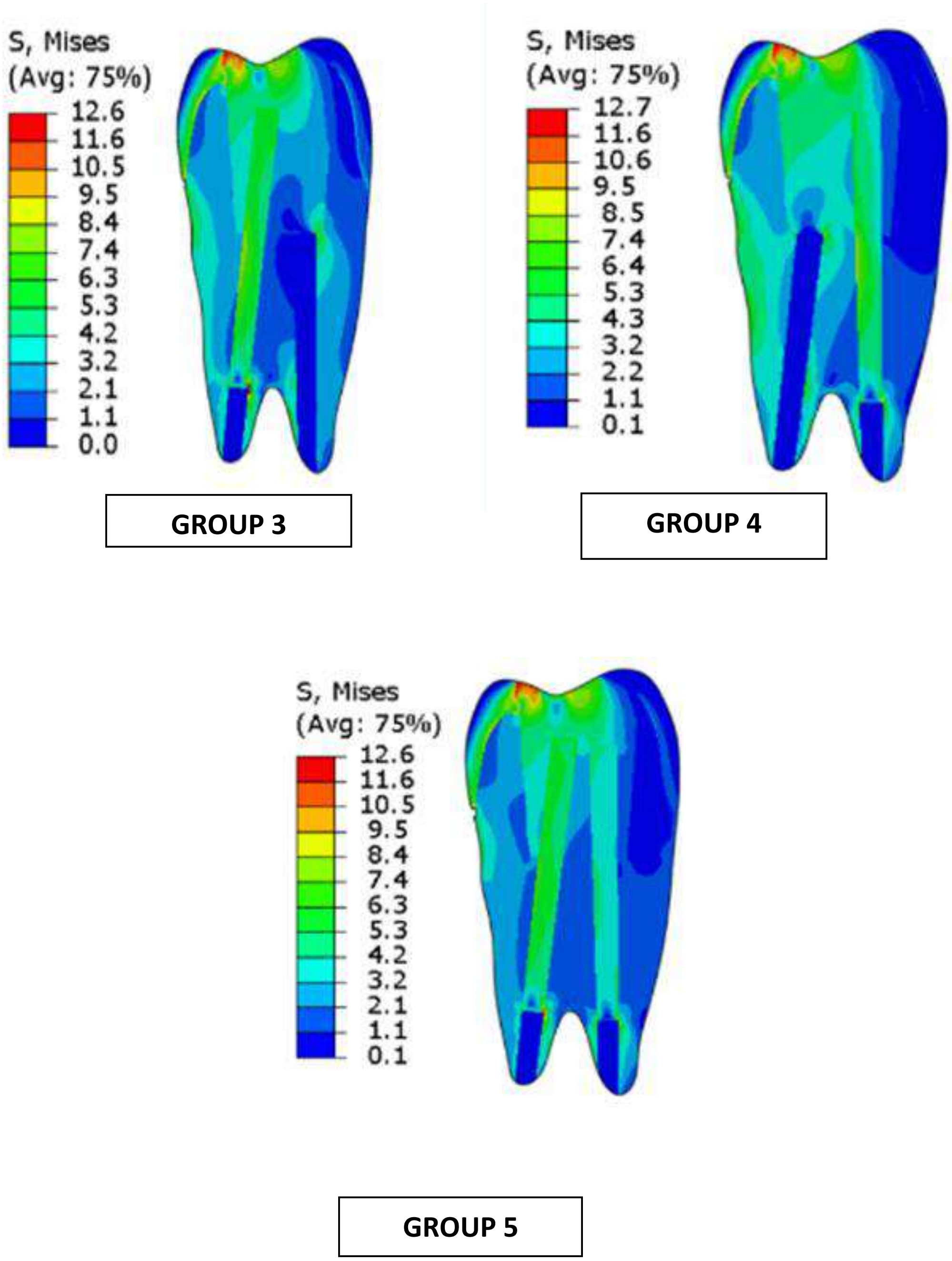
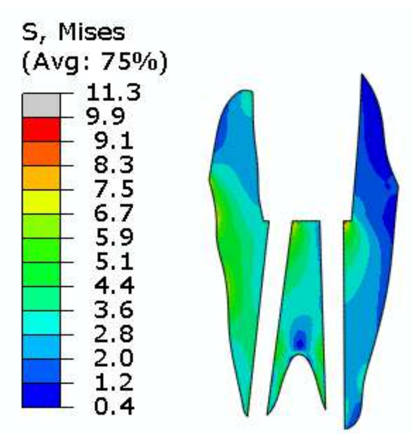


Figure 1. Von Mises maps and Maximum Von Mises stress values (MPa) recorded on the middle buccal–palatal plane

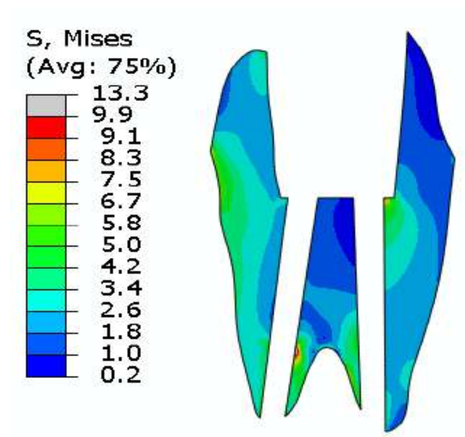
In every group, the highest Von Mises stress values were observed on the occlusal aspect of the outer model surface. In the groups where the tooth was not intact (Groups 2–5), the highest stress values ranged between 12.6 and 11.6 MPa and seemed concentrated at the occlusal interface between the composite and tooth structure. In addition, dealing with the buccal–palatal sections (Figure 1), the maximum Von Mises stress values were observed toward the occlusal surface of each model and seemed concentrated along the composite/tooth interface.

When focusing on the root, the stress distribution maps of restored teeth (Groups 2–5) revealed that the stress concentration on the external root surface was higher in the cervical regions. The lowest maximum Von Mises stress value was observed on the outer surface of the intact tooth (3.5 MPa), while the highest Von Mises stress values were recorded within the body of the fiber post (8.4Mpa) in Group 5 providing a favourable stress distribution pattern along the remaining root dentin.

Similarly, at the root-furcation level (Figure 2), the lowest Von Mises stress value among the restored models were found with group 5 (1.9Mpa) and the highest stress values were observed inside the fiber post in Group 2 (6.7Mpa).



GROUP 2



GROUP 3

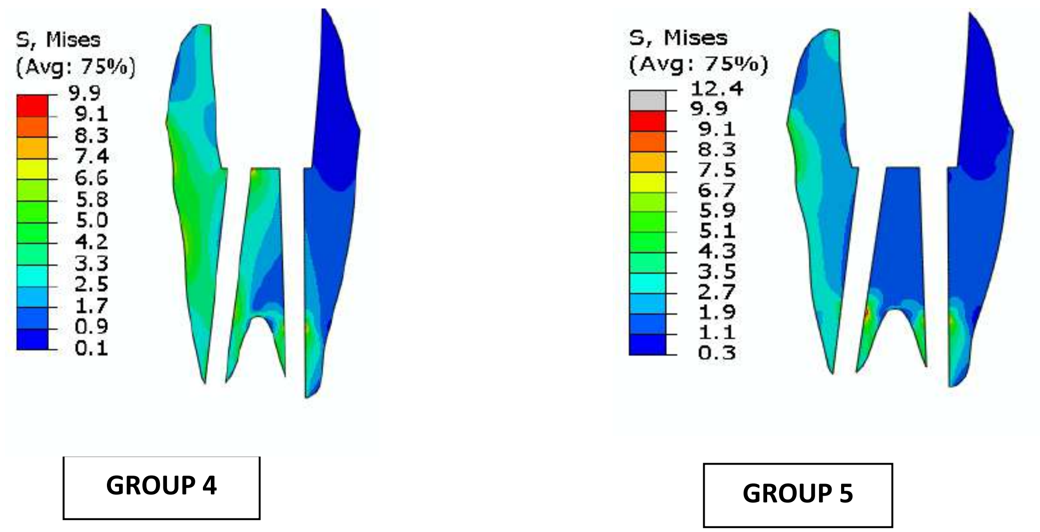


Figure 2. Von Mises maps and Maximum Von Mises stress values (MPa) recorded on the dentin region

Region	Stress level
Cervical area	Group 5 < group 4 <group3 <group 2
Furcation area	Group 5 < group4-group3 <group2

Discussion

The present study is a finite element analysis which is a computerized method to obtain a precise and reproducible model to predict stress-strain behaviour representing the clinical reality. It helps us find the areas of maximum stress concentration and allows us to identify the areas that could lead to failure of the restoration.[12] Previously, other methods including the stress gauge method and photoelastic studies were performed by investigators to asses stress concentration. The advantage of FEA is that the experimental condition can be kept identical in all the models, which is not possible in the experimental human study.

In the present study, the highest stress values were shown at the occlusal surface, regardless of the type of post endo restoration. These findings were supported by previous studies that reported a dramatic increase in principal stress when the access cavity margin approached load points.[11] It is due to the broader tooth-to-composite interface hinders a smooth transition of stresses, as suggested by Jiang et al.[13]

In the study, the stress generated in the post placed in the palatal root was found to be less than the one placed in the buccal root. This could be attributed to the direction of the force exerted on the palatal cusp, which means that the palatal post is closer to the fracture fulcrum, and thus receives less stress compared to the post placed in the buccal canal[2].The theory of a positive stress redistribution away from the cervical radicular dentin, when fiber posts are used in both the canals, supports with the results of a previous study by Sorrentino, who demonstrated that endodontically treated premolars of MOD cavity with fiber posts generally underwent restorable failures.

Conclusion

Within the limitations of the study, the maximum stresses were concentrated at the occlusal interfaces between the tooth and composite, which indicates those areas to be critical for fractures originating from the coronal portion of the tooth. The use of adhesive fiber posts was neither able to reduce the maximum Von Mises stresses recorded on the occlusal surface, nor to optimize the stress distribution in the same areas. In radicular dentin, when fibre post is placed, the von mises maps provided a more favourable stress distribution.

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Original Research

THE BIOMIMETIC RESTORATIVE APPROACH

*Kavya Belaram, **Princy Paul, ***Elsy P Simon

Abstract

Dr David Clark has introduced the innovative method of composite restoration, the bioclear method which has changed the course of dental restorations by bringing new dimensions to aesthetics and function through cutting edge procedural advantage. It involves five pillars:

- The removal of biofilm before bonding,
- Preparations for composite maximizing enamel involvement,
- The use of clear anatomically shaped mylar matrices,
- Injection molding warm 3M Filtek composite, and
- Establishing the final "rock star" polish.

These allow the conservation of enamel and create long lasting restorations.

Key Words: *Bioclear, Calalily design, Fissurotomy, Injection molded heated composite.*

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Introduction

Conventional class II cavity preparation originated around 120 years back. Amalgam restoration procedures are tedious since they include metal band placement, difficulty in manipulation procedure, and forcible compaction of amalgam.

The conventional preparation was followed in composite restorations since its introduction. over the years many gadgets and techniques have developed to help handle composite resins predictably using traditional metal matrix bands.[1]

Dr.Richard Simonson is widely recognized as a pioneer in new cavity preparation shapes for minimally invasive, bonded, resin-based posterior composites. Dr David Clark modernized cavity preparations to shapes that would take advantage of the mechanical properties of this material to make stronger, predictable, longer-lasting class 2 restorations. This includes bioclear method and bioclear matrices which are replacing the traditional G.V. Black Class II restorations with a modern, science-proven procedure that aims to strengthen and prolong the service life of posterior composites.

The Fissurotomy™ Class I, Cala Lilly Class I and the Clark Class II are fairly radical departures from GV Black's system of preparing and restoring posterior teeth. These new cavity designs are based on adhesive composite restorative materials and are engineered to resist tooth fracture.[2,3].

Problems associated with current posterior composite placement techniques

1. Composite is poor biological space filler. A biological space filler such as amalgam or gold foil does not require any adhesion to the tooth surface. Composite on the other hand must be sealed 360 degrees and from inside to out.
2. "Packing composite into a hole" is not a predictable method. The best margin is no margin, and when composite extends slightly past the cavo-surface margin, it is generally well sealed with no white line. When we polish back to the margin, the white line often appears. "Composite sealing" with thin resins applied after filling the cavity may reduce wear[4].

Five pillars to the bioclear method

1. **Biofilm Removal**: Removal of biofilm provides a clean surface for the adhesion of composite resins, which in turn reduces staining and recurrent caries at the tooth-restoration interface. Liberally applying a disclosing solution, Bioclear Dual-Colour

Disclosing Solution, followed by removal with Bioclear Blasting Powder (Al_2OH_3 powder in a high-pressure Blaster (Bioclear), provides a clean surface for bonding . The aluminum tri-hydroxide powder removes biofilm safely without damaging tooth structure.

2. **Preparation Design:**

The Clark Class II preparation is designed to minimize stress concentration, facilitate the flow of warm composite resin, and increase the surface area of enamel bonding. Boxes and bevels are no longer needed, and it is no longer necessary to cut dentin to create mechanical retention. The square corners and sharp lines of G.V. Black preparations are unfavourable for composite bonding. Polymerization contraction forces (C-factor) increase with the number of bonded surfaces of a cavity preparation.

A Bioclear Diamond Wedge is ideal for pre-wedging due to its 2 lbs of separation force, it's expanding leading point that locks it into place, and its robust spine that will endure bur contact. Once the pre-wedge is in place, initial access to caries is made with a tapered diamond bur leaving the contact intact.

The contact is now broken toward the buccal and lingual using a blunt needle diamond bur, and the preparation is extended into an infinity margin several millimeters onto the buccal and lingual surfaces. After removing the pre-wedge, a safe-sided finishing strip further blends the margin and softens any edges. The occlusal cavo-surface margin is similarly flared. Designing broad, smooth radius walls on enamel increases bonding surface area and minimizes shrinkage stress. Dentin is instrumented only to remove decay.

3. **Anatomic tooth forms (Bioclear matrices)**

Bioclear matrices mimic the natural anatomy of anterior and posterior teeth. They come in different shapes and heights to accommodate different clinical scenarios.

The matrices are transparent to facilitate curing of the resin and are stiffer than metal matrices. Bioclear Diamond Wedge is placed to stabilize the matrix.

4. **Injection-molded heated composite**

Once the preparation has been etched, rinsed and its adhesive light-cured, a second application of adhesive is applied, air-thinned but not polymerized. Flowable composite, heated in a HeatSync (Bioclear) along with two loaded composite guns to 155°F (68°C) is injected in between the matrix and the tooth, following the U-shape of the preparation. Immediately the heated paste composite is injected into the uncured flowable and adhesive allowing the backpressure to gently lift the tip out of the tooth until the entire preparation is filled beyond the occlusal cavo-surface margin.

5. **Rock Star Polish**

First, the pre-polish is completed with a worn SoFlex XT disc (3M ESPE) to create a matte finish and to remove any deep scratches left by the diamond bur. Next comes the two-step polish. Magic Mix (Bioclear),it is a dual abrasive prepolish paste which is used in a disposable cup to create omnidirectional super-fine scratches. Next, the Magic Mix is completely removed with air-water spray.

Finally, a diamond impregnated cup (RSP Polisher, Bioclear) is used with light pressure. Care should be taken with any polisher used without water spray coolant, as it can create heat. Then the same diamond impregnated cup is used with copious air-water spray and heavy pressure to achieve the ultraglossy appearance. This process sets the injection molded restoration apart from the often-grainy finish of "bonding[5].

Fissurotomy Technique:

This involves five important components

1. 'Sealing over' the hidden incipient caries.
2. The Fissurotomy™ NTF Bur are used, which is ideal for ultraconservative micro

preparations of pit and fissure defects.

3. Each occlusal defect is addressed separately
4. The restorative material of choice is a robust, filled composite such as a flowable composite and/or heated paste composite
5. The use of advanced clinical magnification ranging from 3.5X to 16X is imperative

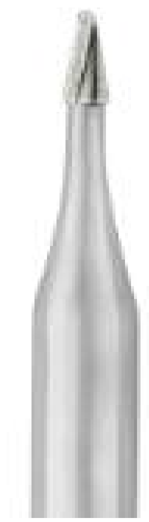

Figure 1: Fissurotomy NTF Bur

Cala Lily Preparation (Occlusal portion)

It describes the new cavity shape for medium to large-sized Class I composites. This provides the adequate volume of enamel rod engagement.

Figure- 2: Cala Lily bur

The Cala Lilly is a flower and is the new model for composite preparations.

Traditional parallel-sided access (*left*), compared with the Cala Lilly enamel preparation (*right*). (*Left*) Unfavorable C factor and poor enamel rod engagement are typically present when removing old amalgam or composite restorations or with traditional endodontic access of 90° to the occlusal table. (*Right*) The enamel is cut back at 45° with the Cala Lilly shape. This modified preparation will now allow engagement of nearly the entire occlusal surface.

The Clark Class II (Interproximal Portion)

This involves preparation with a serpentine or disappearing margin.[2]

Fig. 1) Bioclear Dual-Colour Disclosing Solution is applied to the tooth to be restored as well as the adjacent teeth.

Fig. 2) After 5 – 10 seconds, the disclosing solution is rinsed off, revealing the location of the biofilm.

Fig. 3) Using a Bioclear Blaster with aluminum tri-hydroxide, the biofilm is removed. Pre-wedging with Bioclear Diamond Wedges is established to protect the rubber dam and gingival papilla from accidental bur damage.

Fig. 4) The old amalgam restoration is removed revealing sharp edges from the G.V. Black preparation.

Fig. 5) The Bioclear non-retentive preparation is complete. Note that all sharp edges are removed and the dentin has been "blasted" with aluminum tri-hydroxide.

Fig. 6) BioFit matrices, Diamond wedges and TwinRing separating rings are in place.

Fig. 7) Preparation has been over-filled with 3M Filtek Supreme Ultra with the injection molding technique.

Fig. 9) Final restoration with Rock Star polish.

Conclusion

The bioclear has shown dramatic reduction in rate of tooth fracturing. This new concept of minimal traumatic cavity preparation and restoration is expected to outlast the class II amalgams. Moreover the simplicity of techniques involved including the use of injection molded heat composite would attract the physicians to the new method.

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Original research

EFFICIENCY OF PASSIVE ULTRASONIC IRRIGATION AND GUTTAPERCHA SOLVENT IN REMOVAL OF ROOT CANAL FILLING MATERIAL USING PROTAPER RETREATMENT SYSTEM

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**Nimmy Kurian

Abstract

Background and Objective: The aim of the present study was to evaluate the efficacy of protaper retreatment instruments with and without guttapercha solvents and also with and without using passive ultrasonic irrigation on the removal of root canal filling material and the time required for its removal.

Materials and Methods: 40 mandibular premolars with single canals were decoronated, the root canals were prepared using the protaper rotary system and obturated with gutta-percha size (25/.06), using lateral compaction technique. Teeth were divided into four equal groups (n = 10) according to the final irrigation technique and gutta percha solvent was used in the removal of root canal filling material. Group 1 includes protaper retreatment system with conventional irrigation and gutta-percha solvent. Group 2 is protaper retreatment system with passive ultrasonic irrigation and gutta percha solvent. Group 3 is protaper retreatment system with conventional irrigation and without gutta-percha solvent and group 4 is protaper retreatment system with passive ultrasonic irrigation and without gutta percha solvent. Roots were split into two halves longitudinally and the canal walls were viewed under digital microscope. The remaining filling material in each root canal third was evaluated using ISO PRO software.

Result: There was a statistically significant difference in the total area percentage of the remaining filling material between ultrasonic irrigation and conventional irrigation. ($P<0.05$). But no significant difference during the use of a gutta percha solvent.

Conclusion: Within the limitation of this in vitro study, Gutta percha removal is more efficient with passive ultrasonic irrigation than conventional irrigation. The time required for gutta-percha removal is faster with the gutta-percha solvents.

***Keywords**: Obturation, Root canal, Retreatment*

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Introduction

A cross sectional survey in 2012 investigated the prognosis of root canal treatment for a period of 7 years and an interesting finding observed was the high percentage of success rate, (80.2%) with a failure rate of 19.4%.[1] The endodontic treatment failure is usually characterised by the presence of post-treatment apical periodontitis, which may be persistent, emergent or recurrent. The major aetiology of post-treatment disease is persistent intraradicular infection, but in some cases a secondary intraradicular infection due to coronal leakage or an extraradicular infection may be the cause of failure.[2]

Understanding the causes of endodontic treatment failure is of paramount importance for the proper management of this condition. Teeth with post-treatment apical periodontitis can be managed by either non-surgical endodontic retreatment or periradicular surgery, both of which have very high chances of restoring the health of the periradicular tissues and maintaining the tooth function in the oral cavity.

When the choice is endodontic non surgical retreatment, then the goal is to access the pulp chamber and remove the materials from the root canal space.[3] The purpose of this study is to evaluate the efficiency of protaper retreatment instruments with and without guttapercha solvents and also with and without using passive ultrasonic irrigation on the removal of root canal filling material and the time required for its removal.

Materials and Methods

The study was designed as an experimental in vitro study. The study was conducted in the department of conservative dentistry and endodontics. 40 extracted human lower premolars weredivided into 4 groups with a sample size of 10 in each group.

Root canal preparation

Forty single-rooted human mandibular premolar teeth, recently extracted due to prosthodontics or periodontal disease, were collected from the department of Oral and Maxillofacial surgery. All the teeth were then decoronated at the cemento-enamel junction with a diamond disc under water coolant, to obtain standardised 16 mm-long root segments. The canal patency was checked by placing a size

10 K-file into the canals until it was visible at the apical foramen. The working length (WL) for canal preparation was established by subtracting 1 mm from the length of the file just visible at the apical foramen. Each root canal was then mechanically prepared with edge endo rotary files in a crown-down manner. Irrigation was done in between and after the canal preparation. Obturation was done using gutta-percha cones and zical sealer.

Removal of the root canal filling material

Roots were randomly divided into four main groups (n = 10) according to the use of gutta perchasolvent and the irrigation technique used for removal of the root canal filling material, as follows- protaper retreatment system with conventional irrigation and gutta-percha solvent, protaper retreatment system with passive ultrasonic irrigation and gutta percha solvent, protaper retreatment system with conventional irrigation and without gutta-percha solvent, protaper retreatment system with passive ultrasonic irrigation and without gutta percha solvent. The retreatment procedure was considered complete when the working length was reached, no material was observed between the flutes of the files and the irrigating solution appeared to be clear of debris. All of the root canals were finally irrigated with 17% EDTA.

Roots were split into two halves longitudinally and the canal walls were viewed under digital microscope. The remaining filling material in each root canal third was evaluated using ISO PRO software. A stopwatch was used to record the time required for root canal filling removal, starting from the moment of entering the canal with the first instrument until the complete gutta-percha removal and final irrigation.

Data of the percentage area of the remaining filling material were statistically analysed using the statistical package for social science version 20(SPSS 20).The Mann Whitney U test was used to compare between the two irrigation techniques as well as the use of gutta-percha solvent. The significance level was set at $P<0.05$.

Figure-1: Sample selection and preparation

Figure -2: Removal of gutta percha using protaper retreatment files

Figure-3: Splitting of the tooth sample

Result

The area percentage of the remaining filling material after using different irrigation techniques and use of gutta percha solvent was then analyzed with the help of ISM PRO software.

GROUPS	n	Mean area
NO CARVENE CONVENTIONAL IRRIGATION	10	8.86 mm square
NO CARVENE ULTRASONIC IRRIGATION	10	6.1 mm square
CARVENE CONVENTIONAL IRRIGATION	10	8.89 mm square
CARVENE ULTRASONIC IRRIGATION	10	7.3 mm square

Statistically significant difference ($P<0.05$) present in the total area percentage of the remaining filling material between ultrasonic irrigation and conventional irrigation. Time required for fillingmaterial removal is less for carvene group. Carvene and without carvene groups shows slight significant difference.

Discussion

The need for non-surgical retreatment is important to remove all the canal filling material, perform further instrumentation and disinfection in the root canal. Various instruments have been proposed for gutta-percha removal; however, rotary instruments have been recommended for their high efficacy, safety and ability to decrease both patient and operator fatigue.[4]

Moreover, irrigation is essential, not only in primary root canal treatment procedures, but also in non-surgical retreatment cases, as it allows more canal debridement beyond that achieved with root canal instrumentation. Several studies have shown that PUI enhances the ability of sodium hypochlorite to remove dentine debris, necrotic tissue and bacteria. However, few studies addressed the efficacy of PUI in removing root canal filling material during endodontic retreatment.[4,5].

In this study, 2.5% NaOCl was used for routine irrigation during the cleaning and shaping steps as it fulfils the majority of the required criteria of an irrigation solution, such as broad antibacterial effect and organic material dissolution ability. Gutta percha solvents tends to be messy and inconvenient as it dissolves rather than softening the gutta-percha, leaving residues on the walls. Hence the grouping was done with and without carvene[5].

Conclusion

Within the limitation of this in vitro study, Gutta percha removal is more efficient with passive ultrasonic irrigation than conventional irrigation but has no significant difference during the usage of carvene gp solvent. The time required for gutta-percha removal is faster with the gutta-percha solvents.

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Review

BIOPHOTONICS IN DENTISTRY

*Divya. K. Raj, **Ravi. S.V, ***Elsy .P. Simon

Abstract

The aim of this review paper is to provide a comprehensive idea about the use and application of photonics in dentistry. This article will present and discuss the relevant aspects of biophotonics in the fields of dentistry. In the recent decades, biophotonics is revolutionizing in the field of medicine, biology and chemistry and creating a new breed of medical engineers and at the same time getting engineers a taste of medicine. In biomedical engineering detection, diagnosis and treatment targeting both macro-objects like the teeth or bone as well as micro-objects such as bacteria have seen better understanding through the development of new tools. Biophotonics is a multi-disciplinary field that bridges engineering, the sciences and medical fields. This review paper provides a comprehensive discussion of its main elements, such as photoelasticity, interferometry techniques, optical coherence tomography, different types of lasers and quantum dots.

Key Words: *Biophotnics, Dentistry, Laser, Quantam dots*

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Introduction

Photonics is a light based optical technology. During the last 50 years, there has been many breakthroughs in photonics which laid foundation for its wide range of applications in health care.[1] Biophotonics is defined as the science of generating and harnessing light (photon) to image, detect and manipulate biologic materials.[2] Most applications of photonics in health care were based on various types of light and different types of photon- tissue interactions and is used to study biologic tissue and biologic processes at different scales that ranges from micro to nano levels. Biophotonics integrates lasers, photonics, biotechnology and nanotechnology. Applications of photonics-based techniques offer several specific advantages such as rapidity, sensitivity, specificity, inexpensive and non- invasive.

Dentistry has traditionally depended on contemporary science and technology for improvement in diagnostic tool and advancement in treatment options. Current dental practice has been emphasizing more on early diagnosis and prevention of common oral diseases and to conserve tooth structure as much as possible during restorative procedure.

The most important benefit of light based diagnostic method is their capability to detect clinically relevant information much early before actual clinical signs and symptoms appear to the patient. This allows photonics based techniques not only to be non- invasive during application, but also detect disease associated tissue changes very early. Early detection of disease process will enable clinician to carry out preventive treatment measures or minimally invasive treatment procedure that are less traumatic and cost effective.

Classification of Biophotonics in Dentistry:

Biophotonics in dentistry is crucial for the early detection of diseases, to carry out more effective minimally-invasive targeted-therapies and to restore diseased tissues functionally and esthetically. Biophotonics in dentistry can be broadly categorized into

1. Research
2. Clinical Applications

Application in Dentistry:

The development of photonics has been invaluable in many dentistry applications, including but not limited to diagnostics, biomechanical studies, treatment of oral cancers and caries and the development of dental prostheses. Photonics applications remain advantageous compared to conventional techniques in that they are non-contact and non-destructive and allow for multiple nanometer scale measurements of over large areas.

1. Photoelasticity

Photoelasticity is an optical characteristic that has been used for experimental stress analysis. Most transparent materials exhibit a temporary birefringence property when exposed to strain and loading due to changes in molecular orientation distribution.[4] This can be utilised to study biomechanics within dentistry and various types of orthodontic movements or structural design.

A model was constructed using a transparent 'photoelastic' material, and the magnitude and direction of occlusal forces was replicated to mimic those experienced in physiological conditions. When these models were placed under stress, they exhibited birefringence, where normally incident light rays split into two parts with two refractive indices and velocities directly related to the stress at that point[5]. Analysis of the birefringence using a polariscope allows for calculation of shear stress.

It has since been used in various studies of dental biomechanics, including investigating the relationship between dental caries and stress concentrations. Photoelasticity has also allowed studies comparing different endodontic dowels, such as the effect of length, diameter and other design parameters on stress distributions.

The photoelasticity technique was used to analyse in vivo stress and strain distributions in human dental supporting structures from the tooth root to the alveolar bones.[6]. An epoxy resin model (Figure 1) was used to represent the tooth and alveolar bone, and a diffuse-light polariscope was used to observe the fringe patterns when loaded with forces applied at different axes to represent forces applied under physiological conditions.

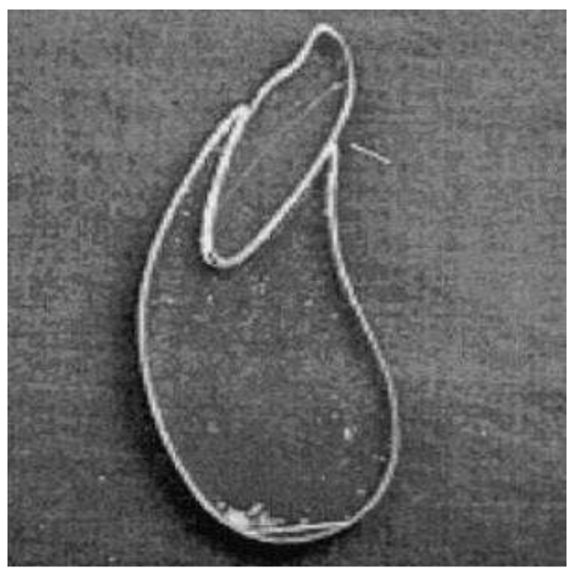


Figure-1: Epoxy resin model used to represent the tooth and alveolar bone

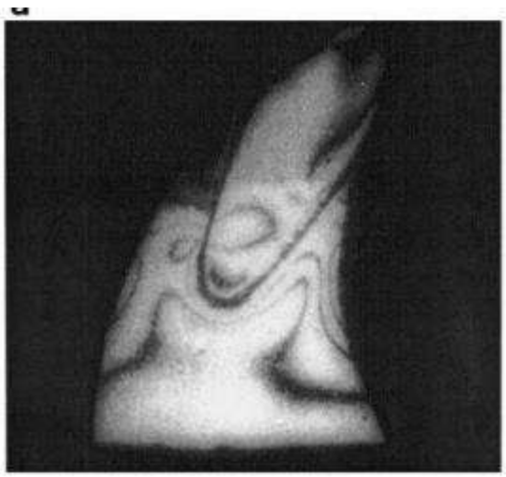


Figure-2: Resultant fringe pattern

The resultant fringe pattern are seen in (Figure-2). Most of the stresses are distributed along the cervical and middle third of the root and the supporting bone. This highlited the role of periodontium in distribution of stresses and bone remodeling.

2. Electronic Speckle Pattern Interferometry

Electronic speckle pattern interferometry (ESPI) is a non-destructive optical technique developed in the 1970s that can also be used to investigate biomechanics in dentistry applications. Specular reflection fringe patterns from surfaces are recorded before and after a load is placed. The images before and after loading are then computed and combined to form a resultant image with a speckle pattern of fringes, allowing for calculation of three dimensional distributions of stress and strain. A schematic of a typical experimental setup of ESPI is shown in (Figure-3).[1] The advantages of ESPI in terms of its capability to take high-sensitivity measurements of surfaces in a non-contact manner.

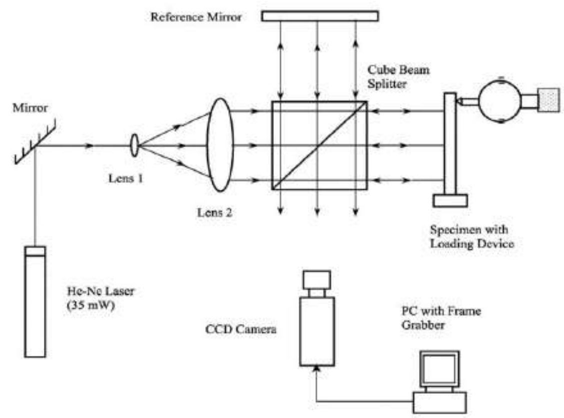


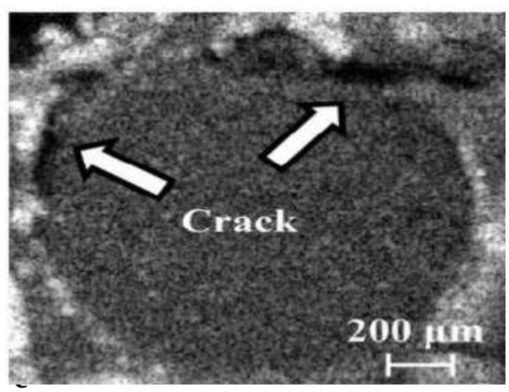
Figure-3: Experimental setup of ESPI

Applications in dentistry have included comparisons between different restorative materials, including gold, ceramic, composite resin or amalgam inlays used to fill dental cavities. The effect of the type of material on deformation of teeth when subject to loading was investigated, with results showing deformation varied depending on the type of material. Another advantageous use of ESPI in dentistry includes the development of a non-destructive test to characterize the modulus of resin-based inlays.

3. Optical Coherence Tomography

Optical coherence tomography (OCT) is a non-invasive, non-destructive, high-resolution, cross-sectional imaging technique widely used in various clinical applications, including ophthalmology, dentistry and gastroenterology. It may be considered equivalent to ultrasound imaging but with light waves instead of ultrasound. OCT is a powerful technique that captures real-time images of tissue in situ without the need for biopsies, achieving image resolution of 1–15 µm, comparable to that of optical microscopy.[1] OCT is another interferometry method using low-coherence light. A photodetector is used to capture interference of reflected and scattered light.

Different systems of OCT have been developed over the years, including doppler OCR (D-OCT), polarisation-sensitive OCT (PS-OCT), spectral-domain OCT (SD-OCT) and endoscopic OCT. The applications of OCT in dentistry and other biomedical applications are vast. OCT was first applied in dentistry in 1998 as a means of capturing in vivo images of hard and soft dental tissues.[7] Another application of OCT in dentistry is the detection of microleakage of restorations and fillings, as well as evaluation of their integrity. This is significant because the early detection of microleakage could prevent secondary caries that arise from accumulated bacteria stuck within microleakages. Figure.4 shows the images of the ceramic/enamel interface obtained by OCT.



-4: The images of the ceramic/enamel interface obtained by OCT.

1. Lasers

Laser was first used in dentistry in the 1960s, and since then, applications have developed massively, rapidly allowing for greater efficiency, ease and comfort in treatments. Laser refers to light amplification by stimulated emission of radiation; concentrated, focused and coherent monochromatic radiation is emitted in single wavelength. When interacting with tissue, this radiation may be transmitted, absorbed, scattered or reflected depending on the optical properties of the tissue and the wavelength of the laser. Various effects may be achieved, including photoablation, photochemical effects, fluorescence and vaporisation. These can be utilised for a vast number of dental applications.

Laser Type	Wavelength	Applications
CO_2	10.6 µm	• Soft tissue ablation • Treatment of lesions • Frenectomy and gingivectomy
Nd:YAG	1.064 µm	• Root canal therapy • Caries removal
Er:YAG	2.94 µm	• Caries removal • Root canal preparation
Er,Cr:YSGG	2.78 µm	• Caries removal • Cavity preparation • Bone ablation • Root canal preparation
Argon	572 nm	• Polymerization of restorative resin materials • Treatment of lesions • Frenectomy and gingivectomy
Diode	810–980 nm	• Promotion of healing of lesions or surgical wounds • Frenectomy and gingivectomy
HO:YAG	2.1 µm	• Treatment of lesions • Frenectomy and gingivectomy

Table:1 Brief summary of commonly used lasers and their applications in dentistry

Photoablation and vaporisation are used to remove tissue; fluorescence can be used to detect caries; and the photochemical effect may be used to initiate chemical reactions, such as curing of composite resin[10]. Lasers can be classified based on level of penetration, such as deep of superficial; wavelength; or application, such as soft tissue and hard tissue lasers.

Table 2. Summary of advantages of laser therapy in dentistry compared to conventional therapies.

Summary of Advantages of Laser Therapy in Dentistry Compared to Conventional Therapies
Reduced need of anaesthesia
Reduces pain with analgesic effects
Haemostatic effects; reduces bleeding and tissue inflammation
Very precise cutting; minimises damage to healthy tissues
Ability to ablate and vaporise dental hard tissues
No issue of painful vibrations caused by conventional equipment, such as dental drills
Microbial and bacterial inhibition
Improved cell metabolism and biostimulation
Patients with higher sensitivity can be treated with photomodulation therapy

4. Quantum Dots

Quantum dots are semiconductor nanocrystals with unique optoelectronic properties; when stimulated and excited, they release energy via single photons. The wavelength of the light emitted is dependent on the size, composition and shape, something which can be easily changed to produce a specific desired wavelength. As the size decreases, the wavelength emitted decreases, and hence, the photoluminescence colour tends towards the blue end of the spectrum. As the size increases, the wavelength emitted increases.

The potential applications for quantum dots in both medical and non-medical fields are various, including fluorescent labels for biomedical imaging and cancer research, photonic devices, sensor materials, quantum communication networks, greater efficiency in LEDs and solar cells, quantum computing, drug delivery and engineered tissues.

Natural teeth emit light at 440 nanometres when exposed to ultraviolet light and in daylight. In order for resin composites to closely resemble the colour and transparency of natural teeth, the optical properties of the resin composites must be considered, and emission under UV must occur at a similar wavelength. However, restorative materials tend to have very different luminescent characteristics. Luminophores inserted into dental resin can be used to alter optical properties, but the result still does not resemble natural teeth. Alves et al. investigated the use of core-shell quantum dots to alter the florescence and optical properties of dental resin composites. The authors proved that the incorporation of core-shell nano-structured CdSe/ZnS quantum dots into dental resins allows tailoring of fluorescence intensity to more closely resemble natural human teeth.[9]

The fluorescence properties of quantum dots were applied to label bacterial cells. This method was then compared to the conventional way of marking bacterial cells using fluorophores, and the use of quantum dots was shown to be more advantageous in achieving single-cell resolution with a standard epifluorescence microscope. This is significant because gaining insight into the interactions between various bacterial species allows for greater understanding of the development of biofilm. Applications of quantum dots in oral cancer research are also of particular interest, as they may be combined with antibodies to bind to specific proteins of tumour cells, thus acting as fluorescent markers for sensitive detection.

5. Photoacoustic Imaging

In the early 1880s, the photoacoustic effect was discovered in numerous studies that finding that when some material are illuminated by modulated light, they can emit sound waves. This technique is carried out by a combination of visible and near-infrared excitation with acoustic detection. In dentistry, photoacoustic techniques have been used for diagnosis of caries, periodontology, dental implants and blood detection in dental pulp. As shown in Figure 5, this system includes a Q-switched Nd:YAG laser (as an incident pulsed light beam source), which is elevated the beam to a certain height using a right-angle prism and multiple mirror assemblies. A part of this beam is divided with a beam splitter and fed to a photodetector, whereas the other part is reflected downwards with a controlled mirror. This precise method is highly reproducible; the amount of the photoacoustic signal is directly related to the light absorbed by the tissue. Such an imaging method can be performed at visible or infrared wavelengths (532 and 1064 nm), but for deep-tissue imaging, a near-infrared wavelength is recommended. Therefore, this technique could be beneficial in dental applications to detect carious lesions in the early stages.

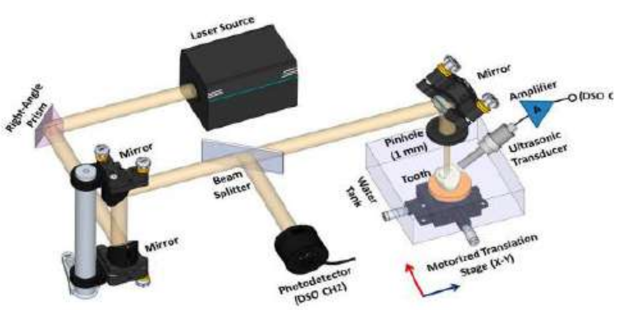


Figure:5

6. **Photothermal Imaging:**

In recent decades, photothermal imaging has been developed as a non-ionizing method for dental imaging to detect caries. With this technique, temperature variation of the subject is measured without contact; therefore, it can detect early caries with better sensitivity. The thermography instrument (Figure 6) includes a heat source; a single detector, such as an IR camera, which monitors surface temperature; a signal generator; and a computer for synchronizing systems to perform signal processing and to reconstruct algorithms. This method is very suitable for imaging biological tissue because thermal-waves do not have resolution and depth limitation of optical or ultrasound waves.[8]

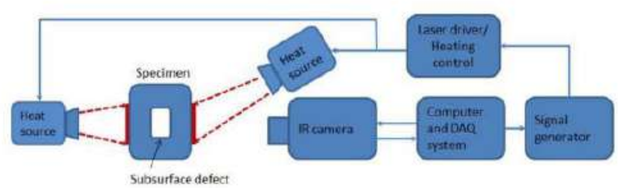


Figure :6

7. **Photobiomodulation (PBM) and ozone treatment:**

Photobiomodulation also known as low- level laser therapy (LLLT) can induce cell proliferation and enhance stem cell differentiation. Studies conducted on the management of periodontal diseases by using photobiomodulation and ozone theray appears to be effective adjuvant treatment to scaling, root planning, obtaining a slightly better outcome for the latter in the long term, with significant differences at T5 and T6 for probing pocket depth.

Conclusion

The complexity of the optical properties of light and biologic tissues and their interactive behavior, makes biophotonics a challenging science. A minimum understanding however, is necessary when utilizing this biotechnology. The specific optical properties of the tissue that will be receiving the specific light, will dictate which laser parameters and treatment protocols are best for the interaction to produce the best outcome and in the safest way.

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Original Research

EVALUATING THE EFFICACY OF RME IN ALTERING THE AIRWAY MORPHOLOGY IN MOUTH BREATHING CHILDREN: A PILOT STUDY

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**Gopika Gopan, **Mubeena T A.

Abstract

Background: Mouth breathing is one of the etiological factor for sleep disordered breathing during childhood. Diagnosing the children who are at risk for developing obstructive sleep apnea and treating them by altering the airway morphology, thereby increasing the quality of their life opens a new era for pediatric dentist. Hence an experimental study to evaluate the effect of rapid maxillary expansion in altering the airway morphology in children with sleep disordered breathing was undertaken.

Aim: To assess the effect of rapid maxillary expansion in altering the airway morphology in children with mouth breathing habit.

Methodology: From the children reported to the outpatient Department of KMCT Dental college, 8 children with mouth breathing habit were enrolled in the study. All the samples were then subjected to a prior clinical ENT evaluation to assess the degree of airway obstruction. Lateral cephalogram analysis was done for assessing the oro-pharyngeal dimension, nasopharyngeal dimension and nasopharyngeal airway patency. A bonded hyrax type RME appliance was given for 3 months. After appliance therapy, again lateral cephalogram analysis was done to evaluate the changes in oro-nasal dimensions.

Result: On comparison of pre and post mean oro-nasal morphological changes using paired sample t-test, oropharyngeal dimension, nasopharyngeal dimension and airway patency showed a highly significant increase in post RME therapy.

Conclusion: The RME appliance therapy was very effective in improving the airway morphology in mouth breathing children.

Key Words; *RME, Expansion, Mouth Breathing.*

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Introduction

Hypertrophy of the adenoids and palatine tonsils is the second most frequent cause of upper respiratory obstruction and mouth breathing in children. Prolonged mouth breathing leads to muscular and postural alterations which can cause dentoskeletal changes.[1] The typical features of mouth breathers are characterized by long face syndrome or adenoid facies.[2] Although mandibular advancement devices plays a key role in improving airway efficiency, rapid maxillary expansion also called as palatal expansion is now emerging as a more promising treatment option. It involves the opening of the mid-palatal suture and movement of palatal shelves away from each other. It is an orthodontic treatment for maxillary constriction, which increases the width of maxilla and reduces the nasal resistance.[3] It is important for the entire health care community to screen and diagnose for mouth breathing in children as young as five years of age. Early diagnosis and treatment of mouth breathing can reduce its effects on facial development and social problems associated with it[4]. So the purpose of this study was to assess the effect of rapid maxillary expansion in altering the airway morphology in children with mouth breathing habit.

Materials and method

This is an in-vivo experimental study conducted in the Department of Pediatric and Preventive Dentistry, KMCT Dental college, Mukkam, Calicut. The duration of the study was 5 months. Study sample include children below 12 years of age who reported to outpatient Department of Pediatric and Preventive Dentistry, KMCT Dental college, with a complaint of mouth breathing habit.

Inclusion criteria:

- Children below 12 years and with mouth breathing habit.
- Children with angles class II malocclusion with maxillary constriction.
- Children diagnosed by ENT for deviated nasal septum, mild tonsillar hypertrophy.

Exclusion criteria:

- Children of parent's not willing to participate in the study.
- Children associated with any syndrome.
- Children who were already diagnosed with advanced stage of obstructive sleep apnea.

After clinical evaluation from the department, all samples received an ENT evaluation to assess the degree of airway obstruction. In the ENT report, the intensity of obstruction were recorded as Grade I (0-25%), Grade II (25-50%), Grade III (50-75%) and Grade IV (75-100%). Children with Grade I and Grade II obstruction were selected for the study. Informed consent was obtained from all parents or guardians. Sample comprised of 8 children with mouth breathing habit, constricted maxillary arch, posterior crossbite and high arched palate. Cephalometric analysis was done at pretreatment for assessing oropharyngeal airway dimension, nasopharyngeal airway dimension, and nasopharyngeal airway patency (Figure 1) (Figure 3)

RME appliance given was bonded hyrax type with a rate of activation of 0.5mm/day that is, single turn per day (Figure 2). Expansion was stopped after 1 month. A post treatment lateral cephalogram was taken to trace the changes in various oro nasal airway morphology that is oropharyngeal airway dimension, nasopharyngeal airway dimension, nasopharyngeal airway patency (Figure 4). After the expansion period, RME Device served as a passive retainer to allow sutural and bony adaptation for another 3 months.

Cephalometric land marks used to assess the oro nasal dimension

Oropharyngeal dimension (IAS) – line connecting posterior pharyngeal wall to anterior pharyngeal wall around gonial angle. # Nasopharyngeal dimension (PNS-AD1) – Distance from PNS to nearest adenoid tissue measured along the line PNS-Ba line. #Nasopharyngeal airway patency (AD1-SP) –Distance from nearest adenoid tissue to most convex point on soft palate (SP).

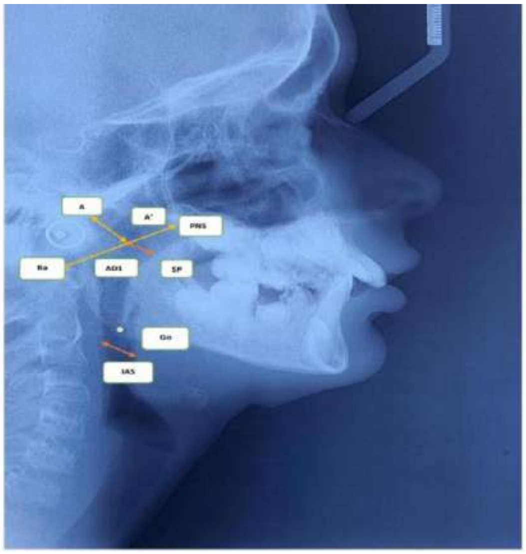


Figure 1 : Cephalometric land marks used to assess the oro nasal dimension

Figure3: Pre-treatment lateral cephalogram tracing.

Figure 2: Bonded hyrax appliance

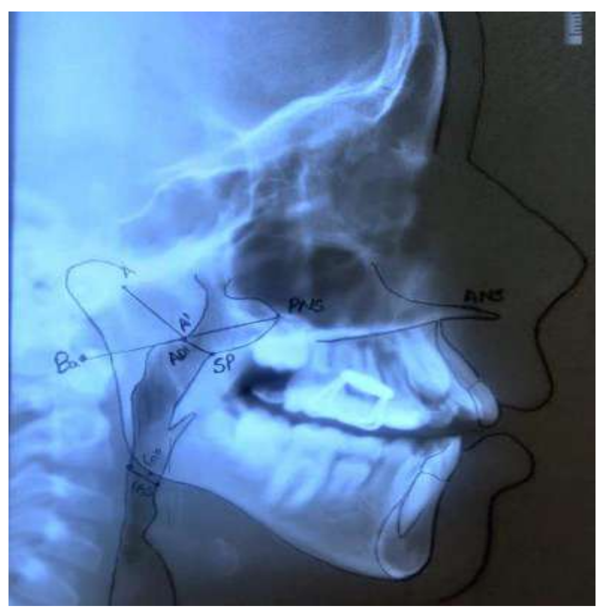


Figure 4: Post treatment lateral cephalogram tracing.

Result

Table I : Mean oro-nasal dimensions at pre RME treatment

Airway dimension	Mean	Standard Deviation	Minimum	Maximum
Oropharyngeal dimension(IAS)	.9	.1	.8	1.0
Nasopharyngeal dimension(PNS-AD1)	1.8	.3	1.5	2.5
Nasopharyngeal airway patency (AD1-SP)	.94	.07	.90	1.10

The oropharyngeal dimension(IAS) mean at baseline as 0.9cm with standard deviation as 0.1. The mean nasopharyngeal dimension at baseline as 1.8cm with standard deviation as 0.3. The mean nasopharyngeal airway patency at baseline as 0.94cm with a standard deviation of .07.

Table II: Mean oro-nasal dimensions at post RME treatment

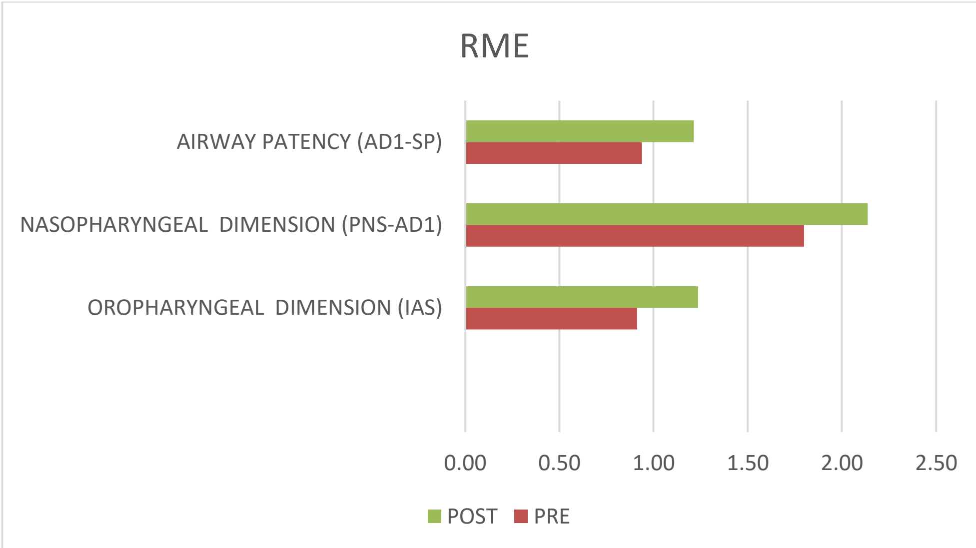
Airway dimension	Mean	Standard Deviation	Minimum	Maximum
Oropharyngeal dimension(IAS)	1.24	.09	1.10	1.30
Nasopharyngeal dimension(PNS-AD1)	2.1	.2	1.9	2.6
Nasopharyngeal airway patency (AD1-SP)	1.21	.10	1.10	1.40

The mean oropharyngeal dimension(IAS) as 1.24cm with standard deviation as 0.09. The mean nasopharyngeal dimension as 2.1cm with standard deviation as 0.2. The mean nasopharyngeal airway patency as 1.21cm with a standard deviation of .10.

Table III: Comparison of oro-nasal dimensions pre and post treatment with RME

		Mean ±SD	Mean difference	t	Degree of freedom(df)	Sig. (2-tailed)
Pair 1	Oro-pharynx dimension baseline - Oro-pharynx Post treatment	1.24±.09	-.32500	-.26588	7	.000
Pair 2	Nasopharyngeal dimension baseline-Nasopharyngeal post treatment	2.1±0.2	-.3375	-.1330	7	.006
Pair 3	RME_Airway patency Baseline - RME_Airway patency post treatment	1.21±.10	-.27500	-.23630	7	.000

The mean difference in oro-nasal dimensions pre and post treatment was compared using paired sample t-test. The difference between the mean in oropharyngeal dimension, nasopharyngeal dimension and nasopharyngeal airway patency was tested significant with mean difference of -.32500 and degree of freedom 7 at a highly significant p-value of **.000**; mean difference of -.3375 and degree of freedom 7 at a highly significant p-value of **.006**; mean difference of -.27500 and degree of freedom 7 at a highly significant p-value of **.000** respectively.



Graph 1: Difference in airway patency, nasopharyngeal dimension, oropharyngeal dimension with RME.

Discussion

The airway is assumed to play a major role in dentofacial development. The association with respiratory problems, especially nasal obstruction, has been the focus of many researchers who have investigated the possibility that these events are related[5]. Rapid maxillary expansion is a dentofacial orthopedic treatment procedure that has been widely used for correcting maxillary transverse deficiency in young patients and it can change the morphology of maxillary arch, affecting geometry and function of nasal cavity[6]. In 1902, Brown described the first case in which nasal blockage was eliminated by the rapid palatal expansion by separating the palatal shelves along with opening of mid palatine suture. There is increase in volume of nasal cavity immediately following expansion, particularly at the floor of nose adjacent to mid palatal suture[7]. Eysel, in 1886, cited by Haas was the first rhinologist who studied the effect of RME on nasal cavity function. He found that, in the post-RME period, various changes occurred in the maxilla and adjacent bones, and RME caused an opening of the nasal cavity and reduction in nasal airway resistance[8].

In our present study bonded type RME was given to 8 children with maxillary constriction and high arched palate. The children were instructed single turn of the expansion screw every day for 1 month till the expansion was achieved, followed by a retention period of 3 months. The mean oro-nasal dimension at pre RME therapy was recorded (Table I). Post oro-nasal dimensions with RME was evaluated after 3 months after desired expansion was achieved for the correction of constricted arch (Table II). On comparison of pre and post mean oro-nasal morphological changes using paired sample t-test, oropharyngeal dimension, nasopharyngeal dimension and airway patency showed a significant increase in post RME therapy(Table III)(Graph I).

This finding was in accordance to some of the studies done by Paola Pirelli et al in 2004 who described a case series of 31 children diagnosed with obstructive sleep apnea syndrome (OSAS) whose AHI (Apnea Hypopnea Index) normalized after RME and remained stable at 4 months[9]. M.P Villa et al in 2011 evaluated 14 OSAS children who underwent RME and demonstrated significant improvement in sleep parameters and symptoms of sleep disordered breathing at 12 months and again in 36 months in a follow-up study of 10 of the original 14 children[3]. Navya Ashok et al in 2014 proved that all children in her study showed an improvement in sleep parameters with an increase in sleep efficiency, decrease in arousal and desaturation index after expansion. Also concluded that rapid maxillary expansion is a useful treatment option for improving quality of sleep in children with sleep disordered breathing. It also induces widening of the maxilla, corrects posterior crossbites and improves maxillary and mandibular dental arch coordination[10].

According to the present study results, the use of RME showed favourable results in the treatment of maxillary constriction and decreased airway resistance; thereby, a possibility is offered that some potential may exist for a young patient to “outgrow” a breathing problem.

Conclusion

This experimental study has paved a way for improving the airway morphology and decreasing chances of development of craniofacial and occlusal anomalies associated in children with mouth breathing habit. These appliance therapies have also resulted in increasing the quality of life in children by increasing their quality of sleep. Early ENT clinical intervention and orthopedic treatment with RME is beneficial in avoiding the development of facial disproportion that need more complicated treatment protocols like surgery. This research can be carried out in a larger sample using CBCT evaluation for airway parameters so that more detailed volumetric measurements and better comparative studies can be made. Pediatric dentist plays a crucial role in screening, diagnosing and providing an early intervention and care for mouth breathing patients.

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Review

DYNAMIC NAVIGATION TECHNOLOGY IN DENTAL IMPLANTOLOGY

*Sheejith.M, **Nivea Francis, ***Arif Jalal

Abstract

Background: Recently, dental implant technology has been widely used for oral reconstruction. Dental implants are the treatment of choice for those patients with dental absences. An optimal implant placement is based on the prosthetic driven concept in order to achieve an aesthetic and functional restoration with a long-term prognosis. Many of the complications associated with the placement of dental implants can be directly related to inaccurate positioning. Implant placement using static guided surgery is very accurate; however, it is possible, due to cone-beam computer tomography (CBCT) discrepancy and/or incorrect placement of the guide, for gross deviations in implant position to occur. Implant surgeons are able to evaluate a patient, scan the patient, plan the implant position, and perform the implant surgery in the same day without the delay or cost of fabrication of a static surgical guide stent.

Objective: To assess the accuracy of dynamic computer-assisted implant surgery.

Materials and Methods: The study consists of a bibliographic review on the topic. The current dynamic navigation workflow requires (1) a CBCT with fiducials (2) virtual implant planning (3) calibration and (4) implant placement in accordance to the 3-D image on the navigation screen. The research has been performed in the PubMed, Scihub, Embase, Medline to identify studies using dynamic navigation in implant surgery, and additional manual search was performed as well.

Results: Various articles were analyzed in the systematic review. The systematic review showed that the deviations in implant placement were significantly lower for dynamic navigation than for the freehand method, and there were no significant differences between the dynamic navigation and static guide methods.

Conclusion: Accuracy of dynamic computer-aided implant surgery reaches a clinically acceptable range and has potential in clinical usage, but more patient-centered outcomes and socio-economic benefits should be reported.

Key Words: *Dynamic navigation, Tooth implants, Implant accuracy, Computer aided, Image-guided surgery*

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Introduction

Computer-assisted dynamic navigation has been commonly used in neurosurgery; orthopedics; and ear, nose, and throat surgery for many years. It has recently been implemented for dental implant surgery. Clinicians using dynamic navigation may use real-time, motion-tracking optical assistance to track the implant drill and patient during preparation of the osteotomy and implant placement to match a digitally planned implant position.[1]

In the recent years, dental implant technology has been widely used for oral reconstruction. Prosthetic restoration after dental rehabilitation with implants for optimal aesthetic restoration has a special significance in dentistry and requires high surgical accuracy. There are many methods nowadays for implant placement such as freehand approach, guided surgery with hand made guides at the laboratory, and finally, the most recent method, computer aided design/computer-aided manufacturing (CAD/CAM) - generated static guides that can be either tooth, mucosa or bone supported - Computer- Assisted Surgery.[2]

Conventional implant placement is performed freehand or using laboratory-made surgical guides. Both are established procedures in dental recovery. Clinically good results and patient satisfaction can be achieved in most patient cases with these procedures.[3] However, these surgical procedures have limitations and operative risks as well, especially in difficult anatomical situations such as the atrophic mandible.[4] Application errors, which are more common for younger surgeons, seem to be the main reason for malfunction.[5] Implant malposition leads to peri-implantitis and craniomandibular dysfunctions, as well as implant loss.[6] Over the last two decades, navigation systems for implantation have constantly evolved to solve these problems and are increasingly used in clinics.[7]

With the establishment of navigation surgery in the dental implant field, the two approaches dynamic and static navigation were introduced. Static navigation refers to the use of static surgical templates for the bone implant drilling sequence and the implant placement.[8] A costume drilling guide is digitally designed as part of the planning process and manufactured prior to the surgery. During the surgery the guide is placed on the patients jaw, mucosa or teeth and the metal sleeves are used to guide the drilling process prior to the implant insertion.[9] This will reproduce the virtual implant position directly from computerized tomographic data to a surgi-cal guide, which prevent any intra-operative change of the implant position.[10]

While, The dynamic approach can be defined as a real-time coordination of the surgeon's hands and eyes by 3-dimensional visualization of the implant preparation with high magnification[11]. It provides real-time guidance to the surgeon, who is operating freehand. A three-dimensional (3D) software allows for the monitoring of the bone drilling and implant placement in real time during the entire length of the procedure.

Dynamic navigation technology

The DN systems available in the United States are a form of computer-assisted surgery (CAS) that use optical tracking. There are 2 types of optical motion tracking systems: active and passive. Active tracking system arrays emit infrared light that is tracked to stereo cameras, and passive tracking system arrays use reflective spheres to reflect infrared light emitted from a light source back to a camera.[12] (Fig : 1)

The patient and drill must be over the line of sight of the tracking camera. The current most commonly utilized DN technology is passive. Light is projected from a light emitting diode light source above the patient. The light is projected down to the patient and the surgical field. The light is reflected off tracking arrays (passive patterned arrays) attached to the patient and the surgical instrument being tracked. The reflected light is captured by a pair of stereo cameras above the patient. The DN system then calculates the position of the patient and the instruments relative to the presurgical plan. This is done real-time, or dynamically. A virtual image is then projected onto a monitor for the surgeon and staff. This virtual reality device allows the surgeon to work dynamically on the patient and execute the planned implant surgery. At any time, the surgeon can change the plan based on the clinical situation.[13]

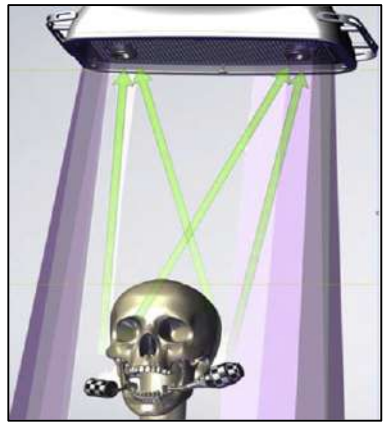

Figure: 1 : The patient and drill must be over the line of sight of the tracking camera

Image acquisition and software planning

Image acquisition includes obtaining 3-D files, usually a CBCT in a Digital Imaging and Communications in Medicine format (.dicom). The field of view of the CBCT or CT should include the surgical site and all fiducials. The scan is obtained with the plane of occlusion of the implant site parallel to floor. An important point related to the acquisition of the CBCT that is often overlooked is the separation of soft tissues while taking the image. For dental implant planning purposes, a cotton roll or radiolucent material place between the dentition and the buccal/labial mucosa creates an air contrast zone. This allows the soft tissue in the region of the free gingival margin to be visualized on the CBCT.[7]

Dual scan is the term used when a dental appliance, such as a set of dentures, is superimposed over a patient's CT scan. If a dual scan technique is utilized, then at least five 2-mm fiducials should be applied to the denture. A high-resolution CT scan is obtained of the denture on its own and then a separate CT scan is obtained with the denture in the patient's mouth, ensuring not to disturb the fiducials on the patient and on the denture.[10]

Another alternative is the use of an intraoral scanner (IOS). An IOS provides a 3-D surface image of the patients' dentition and occlusion. These are not volumetric images; IOS images are a surface. IOS images have a high degree of accuracy for single and quadrant impressions. When full arches are scanned, the accuracy decreases.[14] The implant team may wish to obtain IOS of the patient before teeth are extracted. If the occlusion is not going to be changed, these images can be saved for later use for planning of ideal implant position and provisional fabrication.

Once the images are acquired and stored, they are loaded into treatment planning software. There are numerous software packages available, but some key features should be present related to image processing and analysis. The software should be able to import and export generic file formats (.dicom and .stl), superimpose the 3-D files, perform dual scan .dicom superimposition and be able to export the images in a common coordinate system as an individual or merged item. When these clean .stl images are superimposed on the CBCT data, the combined images allow the implant team to plan, with the osseous, dental, and soft tissue structures clearly visible along with the patient's occlusion.[(15)]

When starting to plan on the DN software, a panoramic curve for the arch requiring implants is developed on the axial plane of the patient's scan. On the mandible, the inferior alveolar nerve also can be identified and marked. Merger of the patient's scan and the IOS image or denture scan is performed, ensuring there are multiple area of coordination between the images for accuracy of the merger.[15]

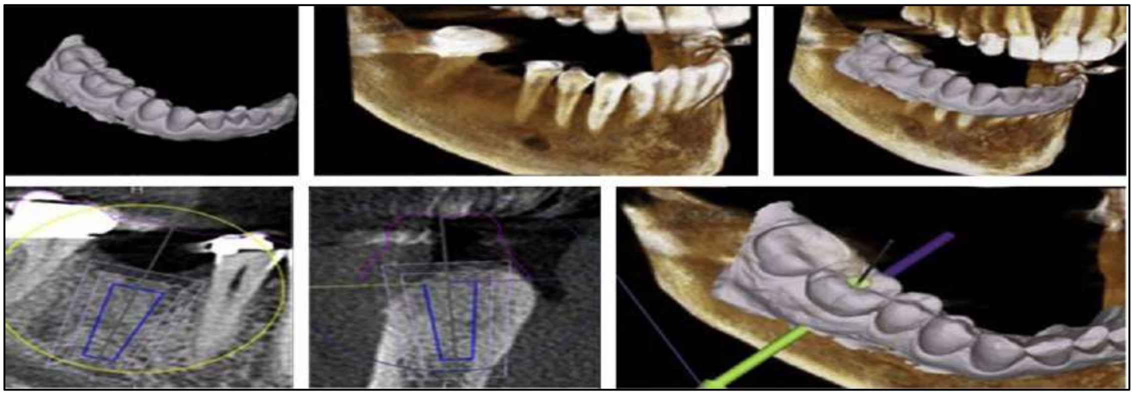

Figure-2: The DN software allows design of a generic implant or previously specified implant, implant platform diameter, implant apex diameter, implant length, and abutment height and angle

The planning of implants should be restoratively driven. This starts with evaluating the occlusion and placing the restorative envelope of the virtual teeth in the proper occlusal position. This can be done using virtual implant crowns available in the DN software. Another option is to use a separate prosthetic software to plan the restorations. The plan is then exported from the prosthetic software and imported as a .stl file into the DN software.[16] Once the implant crown is finalized, the virtual implants should be properly aligned below the virtual crowns for ideal emergence into the prosthetic space. The DN software allows design of a generic implant or previously specified implant, implant platform diameter, implant apex diameter, implant length, and abutment height and angle (Fig:2).[15] Additional tools in the DN software allow mirroring to align implants across an arch and paralleling of adjacent implants.

Calibration

The instruments to be tracked by the system during surgery must be calibrated. The geometry of the tracking arrays relative to the instrument being used must be determined by the tracking system.[15] The assembled parts must be placed in front of the stereo cameras so the software can "learn" their geometry. The instruments to be calibrated include the contra-angle handpiece, straight handpiece and probe tool.

Registration

The DN system must also be "taught" the geometry of the patient tracking array relative to the fiducials and thus the planned implants. This process is called registration. There is a specific registration workflow for both the dentate and the edentulous patient.[15]

Workflow

The user may select a contra-angle handpiece, probe tool, and straight handpiece. At a minimum, the user must select a handpiece. The workflow adjusts to allow for calibration of the selected items. The calibration of the instrumentation occurs approximately 60 cm to 80 cm from the camera. The contra-angle handpiece along with the handpiece tracker is assembled and calibrated (Fig 3). The handpiece is rotated such that the camera can locate and identify the patterns on the handpiece tracker. After calibration of the handpiece, there is a contra-angle handpiece chuck calibration. The handpiece is attached to the chuck and then the drill motor is run at 10 to 20 revolutions per minute over the camera to calibrate the chuck plate to the handpiece. A Go Plate and probe are calibrated by placing the probe in the pivot hole of the Go Plate. An implant drill bit is placed on the handpiece and the implant drill bit is placed on the Go Plate perpendicular to the center target. The drill length is then verified by the DN system. If drill length measurement registration fails, then the handpiece chuck calibration may need to be executed again.[(15)]

In the edentulous patient, an edentulous patient calibration probe is calibrated. Then, the edentulous tracker plate is placed on the bone of the patient underneath a subperiosteal flap in an area of the bone where there are no edentulous fiducial screws. The tracker plate is attached to a patient tracker arm and patient tracker. The patient tracker and the edentulous fiducial screws are then registered to the DN system by touching the screws (fiducials) with the probe as the system tracks them. For the dentate patient, the fiducial clip attached to a patient tracker arm and patient tracker is registerd automatically by the system at the time of calibration.[15]

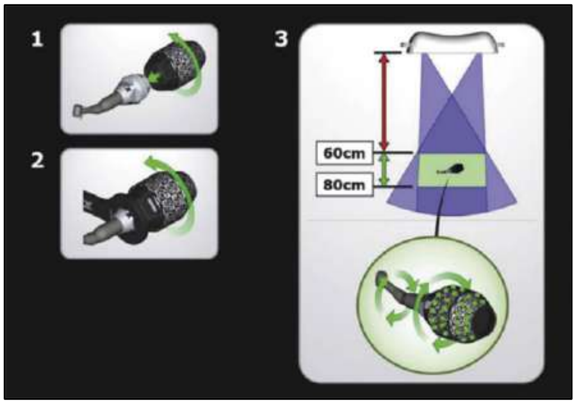

Figure: 3 The contra-angle handpiece along with the handpiece tracker is assembled and calibrated

The calibration accuracy is verified between the fiducials and the drill. The drill bit is placed on 3 fiducial spheres on the fiducial clip for the dentate patient or the edentulous fiducial screws. The doctor looks at the two dimensional (2-D) views for accuracy data in green colors. If all three fiducials have green indicators the system calibration is within 200 micrometers. This step is not performed with edentulous patients.[15]

Prior to the start of surgery and after every drill bit is changed there is a "system check" performed by the doctor. This step ensures the instruments are calibrated and the system is properly registered to the patient.[15]

Performing dynamic navigation surgery

It is important to always confirm the accuracy of the tracking system by performing frequent system checks. Anatomical landmarks on the patient are touched with the instruments. The doctor then visually confirms that the radiographic landmarks on the screen are exactly correlating. The optimal landmarks are adjacent teeth or boney landmarks close to the planned implant site or fiducial markers on edentulous patients. The operator looks at the screen as the drill is positioned over the surgical site.[(15)] The navigation system screen allows viewing of a virtual drill with demonstration of the depth in tenths of a millimeter, angular deviation of the drill bit axis from the planned implant axis to the tenths of a degree and the implant timing.[(17)] (Fig: 4).

Figure- 4: Performing implant surgery by navigation surgery

The tip of the drill, a blue dot, is positioned over the target to indicate ideal planned platform position. The top of the drill a small circle is then centered over the blue dot to indicate ideal planned angle. Depth is indicated by color, yellow, green the red. The planned depth is always at the 45 position on the target (Fig: 5).The surgical assistant is in charge of suctioning and looking into the surgical field to notify the surgeon of any irregularities such as lack of irrigation or grossly off-positioned drill placement. As implant drilling occurs, the depth indicator changes in color from green to yellow when the drill is 0.5mm from the targeted depth. The yellow will turn to red indicating when to stop the depth of the osteotomy.[15] During the implant surgery the implant size, width, type and location can be adjusted based on intraoperative factors deemed necessary for a stable and appropriately restorable implant.[17]

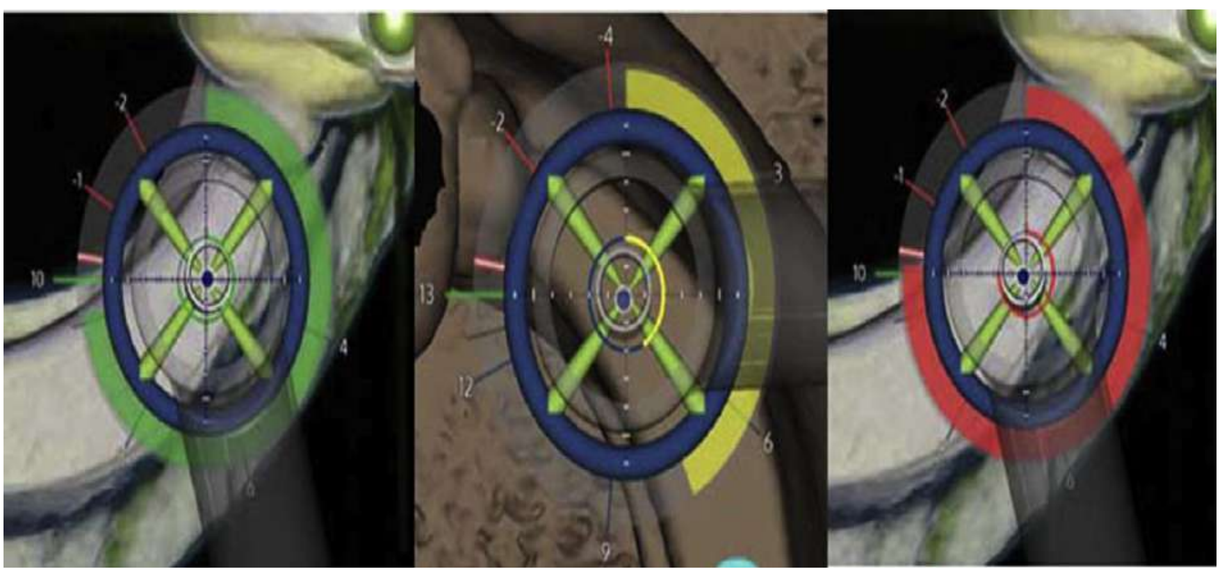

Figure: 5 As implant drilling occurs, the depth indicator changes in color from green to yellow when the drill is 0.5 mm from the targeted depth. The yellow turns to red, indicating when to stop the depth of the osteotomy

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