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Gujarat State Branch

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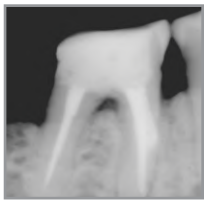

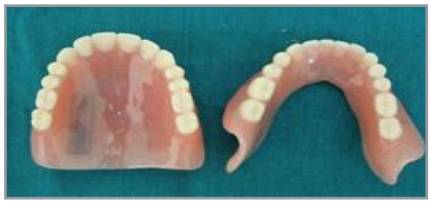

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Guest Editorial

Dear colleagues,

Season's Greetings,

Over last six decades, the science of dentistry has grown exponentially due to relentless and untiring efforts in research & today's dental scenario is undisputedly dominated by latest innovations, which have given new definition to the dentistry.

I congratulate IDA Gujarat for restarting the "Dentimedia" with regular volumes, special congratulations to Dr Amish Mehta & the editorial board.

Herewith I would also like to share few things about the marketing and advertising dentistry. Advertising and marketing of dentistry in the modern day and age has been a matter of great debate and discussion.

In India, we have been seeing a sudden spurt in advertising of dental services. Absolutely outrageous claims in terms of services and modalities, with no supporting scientific and or clinical evidence, have been repeatedly published in different forms & media all over the country, violating ethical regulations.

We, the state dental councils, who are the governing body and, guardians are intending to take a strong stand and strict action against such practices. There is also a very real need to review current advertising guidelines and standards for dental practices in the country.

As a president Gujarat state dental council and also associated with IDA, I would like to urge my fellow colleagues not to violate code of ethical regulations 1976 about the marketing and advertisements of dental practices.

Dr Viral I Patel

President Gujarat State Dental Council

Past President IDA Ahmedabad

Prof & Head, Dept of Periodontology & Implantology, CDSRC, Ahmedabad

Greetings from IDA GUJARAT STATE BRANCH

Dear colleagues,

"Change is the only constant factor in life."Dentistry is one such branch which is constantly developing and evolving in leaps & bounds.I consider myself very lucky to be a part of such a stream which is in its metamorphic and progressive times.

Although we have reached almost half way in this year,we have seen some good CDE programmes hosted by various local branches.The young and enthusiastic dentist so eager to receive knowledge at all levels are constantly updating their skills.I also appeal all the doctors of the fraternity to explore and accept new technologies of treatment to reinvent their style of working which in turn will be beneficial to both their practice & patients.

In the end I wish you very successful & happy times ahead.

Yours in IDA, Jai Hind Jai IDA,

Dr. Nilesh Raval

President

Dr. Nitin Parikh

Hon. State Secretary

A Case Report

CONTENTS

This is my last issue as an editor and I express my gratitude towards its end.
For future correspondence, please contact newly elected Hon. Editor.

'C Shaped Canal - An Endodontic Challenge'

Dr. Medha Jain[a]

Abstract :

Recognition of anatomical variations is a challenge for clinicians. C shaped canal configuration is an important variation which presents as a fin or web, connecting individual canals, which makes debridement and obturation more challenging. This report describes a case of a Mandibular second molar with C shaped canal. The operating microscope is an excellent tool for identifying and managing this complex root canal system

Key Words : C-shaped canals, Mandibular second molar, Anatomical variation, surgical operating microscope

Introduction

C shaped canals were first documented in Endodontic literature by Cooke and Cox[1] in 1979 and are so named as the cross sectional morphology of the root and the root canal resembles the letter C. The C shaped canal is most commonly found in mandibular second molars[2]. Its occurrence in different population varies from 2.7 to 31.5% and is most common in Asian population[3]. The characteristic feature of C shaped canal configuration is a fused root with a longitudinal groove in the middle of the root on the lingual or buccal aspect with the pulp chamber floor usually deeply positioned. The basic anatomical feature is the presence of an isthmus, fin or web connecting the individual canals. Once recognized, it provides a challenge with respect to debridement and obturation, especially because it is unclear whether the C shaped orifice found on the floor of the pulp chamber actually continues to the apical third of the root[4,5.] This article reports a case of C shaped canal in a mandibular second molar and discusses the diagnosis and treatment recommendations for this root canal aberration.

Clinical report

A 62 year old female patient of Asian origin reported with the complaint of sensitivity to cold and hot for the last 10-12 days in lower right posterior region. Clinical examination revealed a class II distal caries in 47 and mild percussion sensitivity. The angled intraoral periapical radiographs revealed a deep distal caries, a fused single root and a slightly blurred diffuse image of the root canals, suggestive of a C shaped canal morphology (Fig. 1a, 1b).

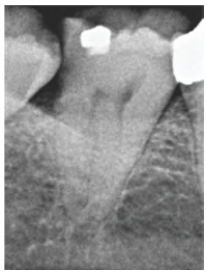

Fig. 1a Pre operative radiograph

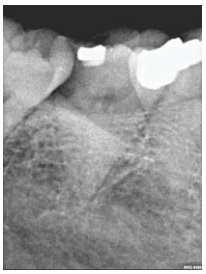

Fig. 1b Pre operative radiograph, angled

The radiograph of the contra-lateral molar showed a similar radiographic image (Fig. 2).

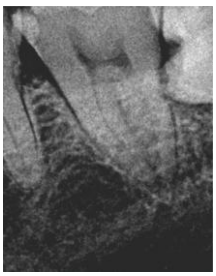

Fig. 2 Radiograph of contralateral molar 37

The pulpal diagnosis was symptomatic irreversible pulpitis, with apical periodontitis. After adequate anesthesia and isolation with rubber dam, access cavity was prepared using burs and ultrasonic under the surgical operating microscope (OPMI PICO, Zeiss). Examination under magnification revealed a separate mesiolingual canal and a deeply

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positioned, C shaped canal orifice, extending from to the mesiobuccal to the distal canal (Fig. 3).

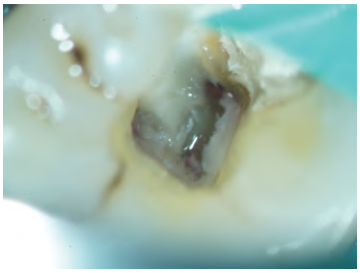

Fig. 3 C shaped canal orifice

Working length was determined with an electronic apex locator (RootZX, J Morita) and verified with the help of an intra oral periapical radiograph, which showed the root canal instruments merging at the apex. (Fig.4)

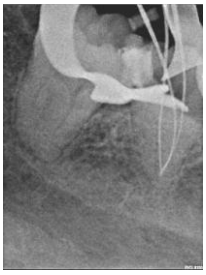

Fig. 4 Working length radiograph

Cleaning and shaping was initiated with Protaper rotary files, followed by circumferential instrumentation using hand instruments. During instrumentation, canal was irrigated with 5 % sodium hypochlorite, followed by 17% EDTA (Fig 5).

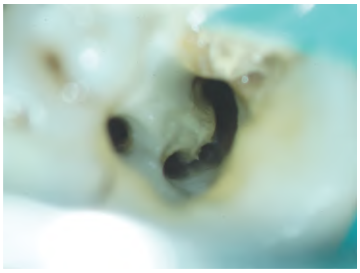

Fig. 5 Canal orifice after shaping with Protapers

The canals were further instrumented with SAF 1.5 mm (Redent Nova, Israel) at a reciprocation of 3000 opm (oscillations per minute) with simultaneous irrigation with 5 % sodium hypochlorite (Fig 6).

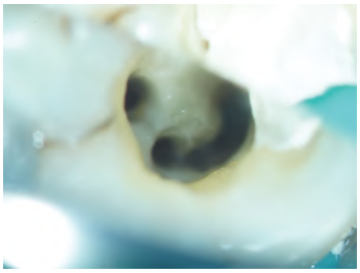

Fig. 6 Canal orifice after shaping with SAF

Obturation was done with gutta percha and AH plus sealer (Dentsply), by continuous wave condensation technique (Fig. 7, 8a, 8b), followed by dual cure composite resin core build up.

Fig 7 Canal obturated with gutta-percha

Discussion

C shaped canal configuration is most often found in mandibular second molars, but has also been reported in maxillary first molars[7], mandibular first and third molars,

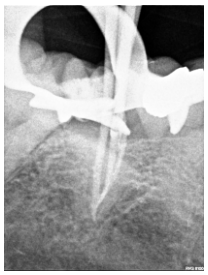

Fig 8a
Master cone x-ray

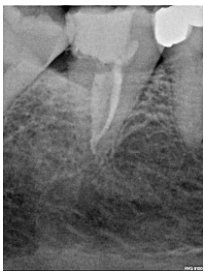

Fig 8 b
Post obturation radiograph

mandibular premolars and maxillary lateral incisor[3]. When present on one side, a C shaped canal may be found in the contra lateral tooth in over 70 % of individuals[3].

The C shaped canal is an anatomical variation which results from the failure of Hertwig's epithelial sheath to develop or fuse on the buccal or the lingual root surface[2].Melton (1991) proposed the following classification based on the different configurations of the orifices in C shaped canal systems[4] Fig 9.

In the pre-operative radiograph, the root canal configuration of molars having C shaped canals may be represented as a single fused root or as two distinct roots with a communication, the latter of which may not be very obvious at first glance. Thus, its recognition is often

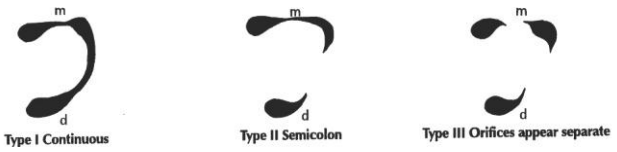

Fig 9 Melton's classification of c shaped canal orifice

improbable, until access to the pulp chamber has been achieved[3]. Cone-beam computed tomography has been shown to be more accurate than digital radiography in determining the root canal system. However it was not possible to use in this case. Nevertheless, the use of operating microscope was helpful in detecting the variations of the root canal system.

An increased volume of irrigant, deeper penetration with small precurved K files, and the use of SAF allows for effective cleaning of fins or isthmus connecting the main canals[8].

Obturation using warm vertical compaction allows better dispersal of endodontic sealer and gutta-percha into the irregularities of C shaped canal system.

Conclusion

Though challenging, with the use of new resources and modification of procedures successful outcome of endodontic procedure can be achieved in C shaped canals.

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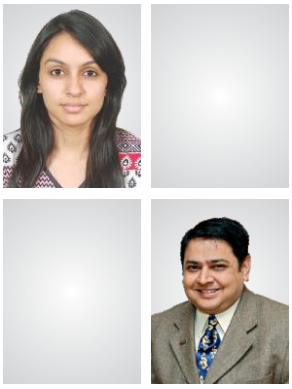
CEMENTUM

Dr. Vijeta Patel[a], Dr. Amit Mendiratta[b], Dr. Harsh Mandan[c], Prof. Dr. Amish Mehta[d]

Abstract :

Cementum is a nonuniform connective tissue that covers the roots of human teeth. Inspite of being one of the four main tissue constituting Periodontium it is least studied mineralized tissue compared to enamel, dentin and pulp. The purpose of this article is to recapitulate molecular-cellular biology, physical properties and chemical properties of Cementum in brief. Considering that orthodontic tooth movement is related to root embedded in socket, periodontal ligament changes and remodelling of bone are usually given more importance, whereas Cementum inspite of its role in tooth movement remains poorly understood. Through this article an attempt has been made to enlighten the orthodontists regarding Basics of Cementum.



Key Words :

Introduction

In humans and other mammals, a soft connective tissue, referred to as the periodontal ligament (PDL), is interposed between the tooth root and the surrounding alveolar bone. These principal fibers are embedded on one side into alveolar bone and on other side in a hard, avascular, nonuniform mineralized tissue covering root surface – "RADICULAR CEMENTUM" (FIG. 1). The embedded terminations are known as " SHARPEY's FIBERS".

Cementum is derived from a Latin word "Caementum"- "Quarried Stone" which means chips of stone used in making mortar . FIG 1: Radicular Cementum:***Cementum constitutes one of the most important structures in odontological histophysiology.***

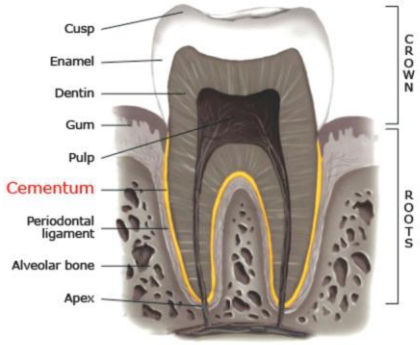


FIG 1: Radicular Cementum:

One of the main functions of cementum is to ***anchor*** the principal collagen fibers of the periodontal ligament to the root surface. It also has important ***adaptative*** and ***reparative functions*** (protects the integrity of the root surface). It plays role in ***active eruption*** by continuous deposition.

The morphogenesis of cementum, basic physical properties and chemical composition have been comprehensively described in various mammalian species. Different types of cementum are found on human teeth. Also, small localized areas of enamel close to the cementoenamel junction (CEJ) are frequently covered with a particular type of cementum.

Cementogenesis, on a cellular level, continues to be poorly understood. Virtually nothing is known about the differentiation mechanisms of cementoprogenitor cells and cell dynamics involved in repair and regeneration process.

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Radicular cementum is unique as it neither has vascular supply nor does it undergo remodelling unlike bone and yet it continues to grow in thickness throughout life. New cementoblasts therefore continuously differentiate from cementoprogenitor cells in order to replace cementoblasts that have reached the end of their life span. During repair and regeneration, the cementoblasts form from same progenitor cells but at much faster rate.

Cementum is thickest at the root apex and in the interradicular areas of multirooted teeth, and thinnest cervically. The thickness cervically is 10–15 m, and apically 50–200 m (although it may exceed 600 m)[1]. (FIG 2)

Zander & Hurzeler[2] stated that the mean, linear rate of cementum deposition on single-rooted teeth is about 3 microm per year. Varies greatly with tooth type, root surface area, and type of cementum being formed. The width of the precementum layer in the human is about 3-5 microm[3,4].

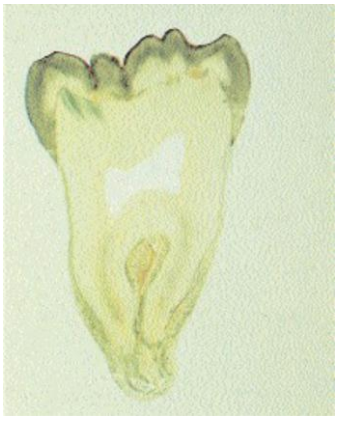


FIG 2: The distribution of cementum (A) along the root of a tooth.

"CEMENTUM AND BONE ARE SIMILAR IN APPEARANCE"

The basic difference is:

- Cementum is deposited throughout life, is avascular, the continuous deposition of cementum increases its thickness with increase in the age.

THEORIES OF CEMENTOGENESIS[5]:

The lack of adequate and confirming evidence regarding the development of cementum has lead to the inception of 2 main theories …

1. THE CLASSICAL THEORY :

The classical theory suggests that mesenchymal cells of the dental follicle become cementoblasts and secrete cementum after having transmitted the barrier of Hertwig's epithelial root sheath.

Originally, the disintegration of HERS and the penetration with connective tissue cells from the dental sac have been described by von Brunn (1891) who believed that the connective tissues of the dental sac were growing into the folds of the enamel organ.

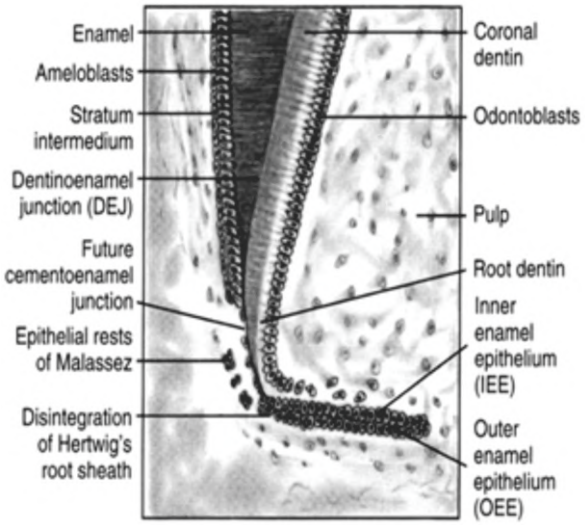


FIG 3: Disintegration of HERS:

2. THE EPITHELIAL CELL THEORY:

A second school of thought proposed that acellular cementum and cementogenesis as a process were originated from epithelial cells. This theory was based on microscopical studies of the lingual cementum of rodent and rabbit incisors as well as on suggested immunological similarities between enamel and cementum proteins. However, this theory was questioned by:

1. Thomas et al (1986)- according to him enamel proteins were absent in murine cementum.

2. Luo et al (1991)- according to him HERS did not transcribe amelogenin.

CEMENTOGENESIS (FIG 3):

Cementum formation in the developing tooth is preceded by deposition of dentin along the inner aspect of ***Hertwig's epithelial root sheath***

Once dentin is formed , breaks occur in the Hertwig's root sheath

Allowing newly formed dentin to contact directly with connective tissue of dental follicle

Cells derived from this connective tissue responsible for the formation of cementum (cementoblasts)

After some cementum lay down, mineralization begins

Uncalcified Matrix Called **Cementoid**

Calcium & phosphate ions present in tissue fluids deposited into the matrix

Arranged as unit cells of hydroxyapatite crystals

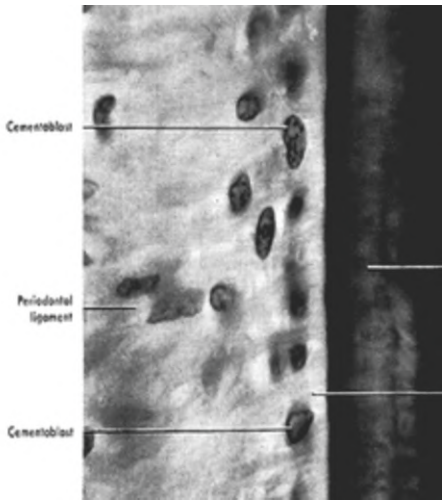


FIG 3: Formation of cementoid and cementum:

PHYSICAL PROPERTIES OF CEMENTUM:

Cementum is pale yellow with a dull surface. It is softer than dentine. Permeability varies with age and the type of cementum, the cellular variety being more permeable. In general, cementum is more permeable than dentine. Like the other dental tissues, permeability decreases with age. The relative softness of cementum, combined with its thinness cervically, means that it is readily removed by abrasion when gingival recession exposes the root surface to the oral environment.

CHEMICAL PROPERTIES OF CEMENTUM:

About 50% of the dry mass is inorganic, and consists of hydroxyapatite crystals. The remaining organic matrix contains largely[6]: Collagen, Glycoprotein, Proteoglycans.

Organic matrix:

The organic matrix of cementum consists primarily of collagens.

- *Type I collagen fibres:* It is the major component, accounting for 90% of all collagens. Provides scaffold for mineral crystals
- Type III collagen fibres: Coats type I collagen fibrils, accounts for only 5%[7]

In most tissues, the collagens play important structural and morphogenic roles. [9] In mineralized tissues, they provide also a scaffold for the mineral crystals.[8]

Noncollagenous proteins:

Cementum is rich in glycoconjugates, which represent glycolipids, glycoproteins or proteoglycans, and harbors a variety of other proteins. Two major non-collagenous proteins: 1. Bone sialoprotein 2. Osteopontin 3. Others: Fibronectin, Osteonectine, Osteocalcin, Proteoglycans, Enzyme alkaline phosphatase, Polypeptide growth factors.

Bone sialoprotein (BSP) and Osteopontin (OPN) are phosphorilated and sulfated glycoproteins. They bind tightly to collagenous matrices and hydroxyapatite, participate in the mineralization process. Fibronectin, Osteonectine, Osteocalcin, proteoglycans- involved in mineralization of cementum.[10, 11] Alkaline Phosphatase is believed to participate in: a. cementum mineralization b. the enzyme activity adjacent to cellular fiber cementum is higher than that to acellular extrinsic fiber cementum.[12]

Polypeptide growth factors: with ability to promote proliferation.[13]

Collagenous protein referred to as *cementum attachment protein (CAP)*, expressed by cementoblasts, promotes the adhesion and spreading of mesenchymal cells. [14,15]

MINERAL COMPOSITION OF CEMENTUM:

Less mineralized than root dentin.[16] Acellular extrinsic fiber cementum appears more highly mineralized than cellular intrinsic fiber cementum and cellular mixed stratified cementum[17]. This can be the reason for presence of uncalcified spaces, such as lacunae and by the uncalcified core of Sharpey's fibers. Hydroxyapatite (Ca10(PO4)6(OH)2), with small amounts of amorphous calcium phosphates is present.[18]

Hydroxyapatite of cementum is not pure, but contains other elements (ions). Cementum contains 0.5- 0.9% magnesium[19, 20] lower at the surface than in deeper layers of cementum.

Cementum has a high fluoride content (up to 0.9% ash weight). The concentration increases with age and vary with fluoride supply [21]. Cementum also contains 0.1-0.3% sulfur as a constituent of the organic matrix [22]. A number of trace elements may be present, in particular Cu+2, Zn+2 and Na+1 [23]; however their significance do not seem to have been studied.

CLASSIFICATION OF CEMENTUM:

A. Classification based on the *PRESENCE OR ABSENCE OF CELLS*:

- Cellular cementum

- Acellular cementum

B. Classification based on the *NATURE AND ORIGIN OF THE ORGANIC MATRIX*:

- Extrinsic fibres

- Intrinsic fibres

- Mixed fibre cementum

C. Classification based on the *PRESENCE OR ABSENCE OF CELLS AND ON THE NATURE AND ORIGIN OF THE ORGANIC MATRIX*:

- Acellular extrinsic fibre cementum

- Cellular intrinsic fibre cementum

- Mixed-fibre cementum

ACELLULAR AFIBRILLAR CEMENTUM:

It covers minor areas of the enamel, particularly at and along the cementoenamel junction (Fig. 4a). A mineralized matrix (similar to the interfibrillar matrix of acellular extrinsic fiber cementum) but contains neither collagen fibrils nor embedded cells. Lack of collagen fibrils- no function in tooth attachment. (Fig. 5a).

Cementum island- isolated patches of acellular afibrillar cementum deposited on the enamel over small areas of the dental crown just coronal to the CEJ. Structure: less homogeneous (multifarious appearance). (Fig. 5a-c).

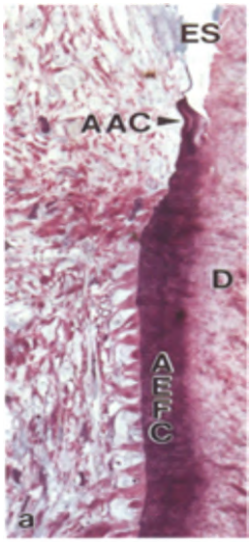
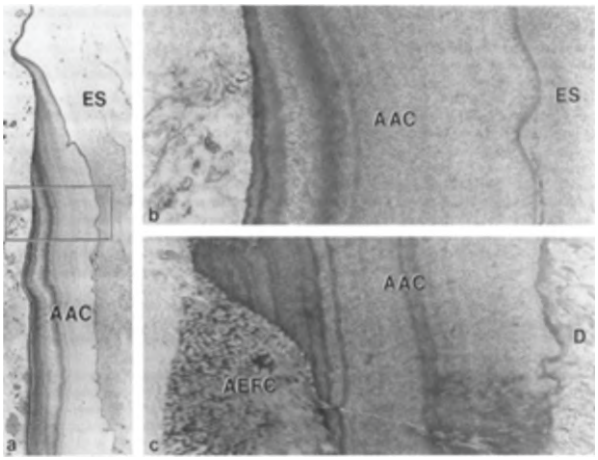


FIG 5: a. The acellular afibrillar cementum opposes to the enamel space b. The acellular afibrillar cementum is characterized by numerous incremental layers with varying electron density and texture. c. In the apical direction, AAF abuts against the dentin (D) and AEFC



ACELLULAR EXTRINSIC FIBER CEMENTUM:

Mainly found on the cervical and middle root portions (Fig. 5a-c). On front teeth, it may also cover part of the apical root portion (the apical extension of acellular extrinsic fiber cementum on the root surface increases from posterior to anterior teeth). Formation commences shortly after crown formation is completed and before cellular intrinsic fiber cementum formation starts.

Cementoblasts producing AEFC commences cell differentiation about 20 to 30 microm coronal to the first

deposited dentinal matrix. The gradual development of AEFC can be followed along the forming root (Fig. 6a, b,d,e).

It consists of a dense fringe of short collagenous fibers that are implanted into the dentinal matrix. Oriented about perpendicularly to the root surface (Fig. 6e, 7a). With the onset of cementum mineralization, the acellular extrinsic fiber cementum commences to grow in thickness (Fig. 7b, c). This growth is extremely slow but quite constant .[24]

The extrinsic fibers remain short until the tooth is about to reach the occlusal level (Fig. 7c). AEFC continues to grow and the numerical density of fibers: approximately 30,000/mm.[25]This reflects role of cementum in tooth anchorage to the surrounding bone.

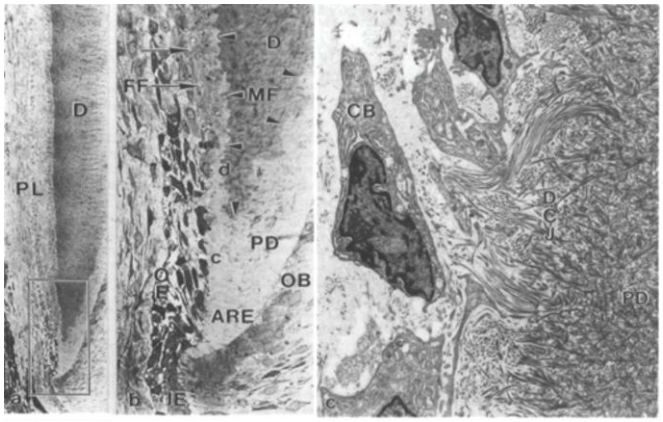
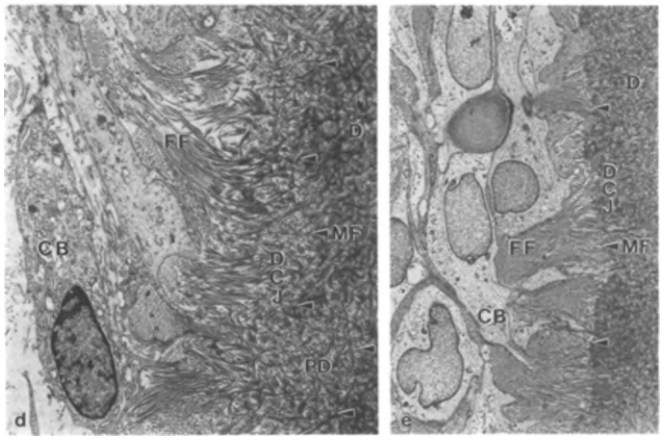


Fig. 6. The initial attachment and gradual development of the acellular extrinsic fiber cementum matrix (that is, fiber fringe; FF) along the apical portion of a human premolar root developed to about 50% of its final length.



Posteruptive tooth movements, changes can occur in the direction of the Sharpey's fibers Changes accentuated by individual AEFC layers interfaced by growth lines also known as ***Resting or Incremental lines*** These lines represent the periodic deposition of cementum layers in frequent association with an abrupt change in the direction of Sharpey's fibers Notable from faster growth rates on distal (4.3 microm/year) than on mesial (1.4 microm/ year) root surfaces [26]. AEFC has the potential to adapt to functionally dictated alterations such as mesial tooth drift.

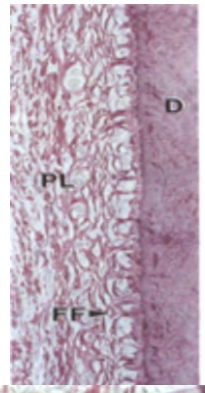
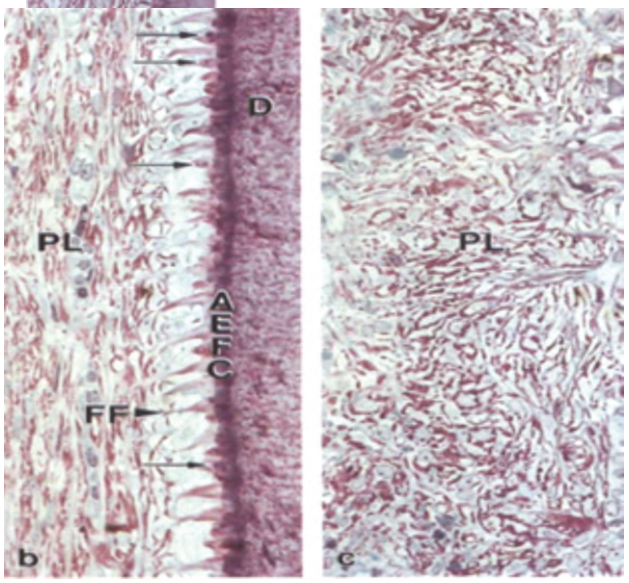


FIG 7a: The AEFC matrix consists of short fringe fibers (FF) that emerge from the root surface and appose to a fibro-cellular meshwork occupying the space of the immature periodontal ligament (PL). A cementum layer is not yet visible.



CELLULAR INTRINSIC FIBER CEMENTUM:

Deposited on root surface areas where no acellular extrinsic fiber cementum has been laid down on the dentin (Fig. d). Sites: in the furcations and on the apical root portions (Fig. 8d) Cellular intrinsic fiber cementum participates in the repair process of previously resorbed roots (Fig. 8g). Contains cementocytes embedded in a collagenous matrix of intrinsic collagen fibers (Figures 8a). Collagen fibers are oriented mostly parallel to the root surface and course in a circular fashion around the root. In rare cases, the intrinsic cementum formed in an unipolar mode of matrix deposition completely lacks cementocytes (Fig. 8d). This particular tissue consisting of densely bundled collagen

fibrils -- *acellular intrinsic fiber cementum (AIFC)*[27]

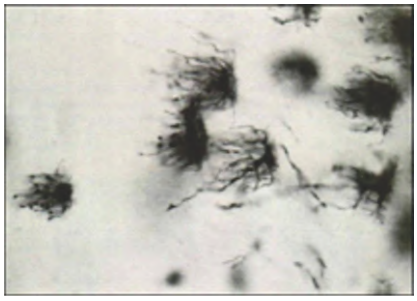
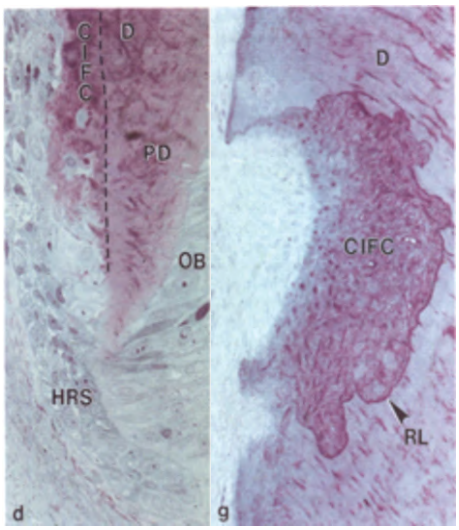


FIG 8a: Notice that the of cementocytes have a tendency to be polarized and extend toward the PDL side of the root.



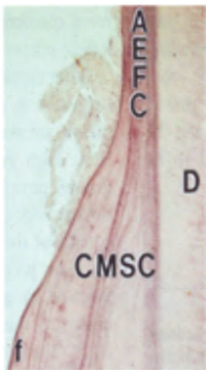
CELLULAR MIXED STRATIFIED CEMENTUM:

In humans, the extrinsic fibers oriented perpendicularly to the root surface and traverse the intrinsic cementum variety either sporadically or densely arrayed in parallel. These less dense and highly aggregated extrinsic fibers 28 of the AEFC matrix intermingle or alternate with the intrinsic fibers. This mixed cementum is referred to as cellular mixed stratified cementum. Extrinsic fibers continuous with the functionally oriented principal fibers of the periodontal ligament--- SHARPEY'S FIBERS. Site: the apical root portions and to the furcations (Fig. 9).

Circumferential deposition of CMSC reflects periods of accelerated deposition of CMSC --- probably due to functional demands in order to reposition the tooth when it is shifting in its bony socket during its post-eruptive tooth movements.

CONCLUSION:

The periodontal tissues form a functional unit designed to maintain tooth support and protection. In particular, cementum, by virtue of its structural and dynamic qualities, provides tooth attachment and maintenance of occlusal relationship. It is beyond the scope of this article to explain all aspects of Cementum in detail.



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Sterilization Protocol for Orthodontic Instruments.

Dr. Maharshi Patel[a], Dr. Darshan Mehta[b]

Abstract :

Pathogenic microbes may be transmitted directly from the dentist to the patient or from the patient to the doctor, and indirectly from patient-to-patient. The latter may occur via contaminated instruments or surfaces, and is referred to as cross-contamination. This presents an enormous challenge in the current scenario as it has been proved that blood and saliva are high-risk sources of contracting hepatitis B, human immunodeficiency virus and herpes. In addition to that mouth is the reservoir of several pathogens which can be easily transmitted from patient-to-patient or to the doctor. Effective sterilization and disinfection techniques must be rigidly followed as per the accepted protocols to prevent the incidence of cross infections in the dental office.

Key Words : Sterilization, orthodontic instruments.

Introduction

Sterilization plays a very important role in the prevention of cross infection in dental practice. Matlack's1 review of orthodontic offices confirmed this insufficiency despite the fact that orthodontic and endodontic offices were at a high-risk of contracting infections like hepatitis.2,3 Although unlike surgeons, orthodontists generally do not work in a blood contaminated area, orthodontic arch wires and ligatures can traumatize patient's mucosa, causing bleeding. The risk of infection is greater for the orthodontist and his staff than for the patients.4 Saliva is one of the modes for nonparenteral spread of hepatitis B.5 HIV and herpes virus complex are other high-risk cross infection spreading through saliva and blood. The current sterilization protocols from an orthodontic perspective is outlined so that it would facilitate the orthodontist in us to make an informed decision towards effectively implementing the protocol for our own safety as well as the patient's welfare.

CATEGORY	DEFINITION	EXAMPLE
Critical	Penetrates soft tissue, contacts bone, enters into or contacts the bloodstream or other normally sterile tissue.	Surgical instruments, periodontal scalers, scalpel blades, surgical dental burs, dental probes, reamers, files and broaches. Orthodontic tried in preformed bands may be considered as a critical item as they have the ability to induce interdental bleeding.
Semi critical	Contacts mucous membrane or nonintact skin; will not penetrate soft tissue, contact bone, enter into or touch other normally sterile tissue	Dental mouth mirror, amalgam condenser, reusable dental impression trays, dental handpieces, orthodontic pliers, elastomeric ligatures.
Noncritical	Contacts intact skin	Dental chair unit, light switch, handles.

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STERILIZATION:

Sterilization is the destruction of all microbial forms including viruses and spores. It is a process that is intended to kill or remove all types of microorganisms, with an acceptably low probability of an organism surviving on any article.

DISINFECTION:

Disinfection refers to the destruction of pathogenic microorganisms only and is often applied to procedures which are incapable of destroying spores and certain resistant pathogenic microorganisms such as tubercle bacilli and hepatitis viruses.

BARRIER TECHNIQUES:

- They form the first-line of defense against infectious and transmissible disease as well as cross infections.
- Gloves must be worn when skin contact with body fluids, mucous membranes or contaminated items and surfaces is anticipated. Between patients, the gloves must be removed and hands must be washed and re-gloved. Latex or vinyl gloves should be used for patient examinations and procedures.
- Heavy rubber (utility) gloves are meant to be used while cleaning instruments and environmental surfaces.
- Hand washing: Hands should be washed at the start of the day, before gloving, after removal of gloves and after touching any contaminated surface. Hand washing with water and plain soap is adequate for patient examination and nonsurgical procedures. For surgical procedures, an antimicrobial hand scrub should be used.
- Face masks protect the oral and nasal mucosa from body fluid spatters. They should be changed when visibly soiled or wet.
- Protective eye wear is indicated to shield the eyes from spatters.
- Protective clothing: Aprons, either reusable or disposable, must be worn in the dental clinic.
- They should be changed when visibly soiled or penetrated by fluids and they should not be worn outside the work area.
- Limiting contamination can be done by three methods.
- Proper patient positioning
- Use of high volume evacuation
- Use of rubber dam.

AUTOCLAVE

Steam autoclave: At 250°F (30 psi), total time about one hour. There is good penetration and it maintains integrity of liquids, like hand piece lubricants, due to the 100% humidity within the chamber.

Disadvantages

- Nonstainless steel metal items corrode, use of hard water may leave deposits, and it may damage plastic and rubber items.
- Sharp instruments get dulled.
- Rapid steam autoclave: At 275°F (35 psi), total time is 15-20 minutes. It is very convenient and easy to operate.
- Requires use of distilled water and small chamber size necessitates frequent cycles.
- According to Boyd6 and Velez7 the sponges do not obstruct the autoclaving process.

CHEMICLAVE OR CHEMICAL VAPOR STERILIZATION:

It is effective against all fungi, viruses and bacteria including spores. Two percent glutaraldehyde solution and chlorine dioxide are commonly used and has been approved by the ADA. Sterilization time with 2% glutaraldehyde is 10 hours without dilution and with chlorine dioxide is six hours when mixedaccording to the manufacturer's recommendation. It is recommended only for heat sensitive nonsurgical instruments and alginate impressions. The main drawback is that this type of sterilization requires prolonged immersion and instrument turnover time is increased. This type of sterilization is not recommended for dental office instruments as there is no method available to verify their effectiveness in providing complete sterilization as well as the fact that present day protocols are combined with heat sterilization for maximum sterilization effectiveness. The other disadvantage is the lingering

unpleasant strong odor in the room where the solution is kept and requires adequate ventilation.

Pitting type of corrosion have been observed in orthodontic cutters and pliers8,9 and there is a compromise in the integrity of the instrument when subjected to chemical disinfectants. Chrome plated pliers appeared more resistant to damage and maintained their appearance better than stainless steel pliers.10

In dental office chemical sterilization is used to disinfect alginate impressions before pouring the model. Recent research11 is directed in finding a alginate disinfecting solution capable of releasing nitric oxide (a broad- spectrum antimicrobial agent) with additional anti-viral activity (herpes simplex virus) which would be a good alternative to the present chemical disinfectants.

Sporicidin solution can be used to disinfect rubber clamps and X-ray holders. For disinfection it requires 10 minutes at room temperature where as for sterilization 6.75 hours is needed. Tincture of metaphen 1:200 (untinted) can be scrubbed against surface to be sterilized for sheath of contra-angle and hand piece, tip of electric pulp tester, tooth clamp and surrounding

area of rubber dam.

Gutta-percha cones are soaked in 5.2% sodium hypochlorite for 1-minute and then rinsed with hydrogen peroxide and dried between two layers of sterile gauze. Dappen dishes can be swabbed with merthiolate followed by 70% alcohol. Long handl instruments, tips of cotton pliers, blades of scissors can be dipped in isopropyl alcohol (90%) and then subjected to flaming before use.

GLASS BEAD STERILIZATION:

Glass bead sterilization uses small glass beads 1.2-1.5 mm in diameter. The recommended temperature is between 217-232°C (424-450°F) and should not exceed 250°C. The duration of the cycle is between 3-5 seconds.

In orthodontics, although the possibility of being able to sterilize 1-2 orthodontic pliers within 30 seconds has been highlighted with a stress on correct positioning for maximum effectiveness,12 these recommendations are deleterious as the instruments are exposed to higher temperature ranges against most manufacturer warnings (193°C/380°F).

Nisalak13 showed that it was possible to kill all the vegetative cells and bacterial spores by scrubbing the contaminated pliers with alcohol and placing in a glass bead sterilizer for three minutes and hence can be a useful adjunct when rapid chair side sterilization is required. Smith14 found that it was possible to relive a single band of bacteria in 15 seconds at 223°C and could be relieved of spores when placed for 45 seconds at a temperature of 226°C but may not practically feasible as sterilization of multiple tried in bands would require more duration which can alter the physical properties of the molar bands.

DRY HEAT STERILIZATION:

Their main advantage is they do not cause instrument corrosion and hence recommended for sterilization of orthodontic pliers and metal hand instruments.

ORTHODONTIC PLIERS STERILIZATION:

The current recommendations for effective sterilization without compromising the longevity of the instruments have been enumerated below. Placement in ultrasonic cleaner for 5-12 minutes depending on the capacity of the unit. Thorough rinsing with distilled water as tap water may contain impurities and pH imbalances which may cause corrosion. Complete moisture removal by drying with oilfree compressed air.

Dry heat sterilization at 190°C for 6-12 minutes.Never expose the instruments to more than 193°C. Position the instruments in the 'open' position to ensure thorough sterilization of joints. Using silicone bases lubricants for the instrument joints. Oil based lubricants are not recommended as they tend to clog the pliers. Storage in a dry area free from moisture and humidity.

Autoclaving should be a second option and is recommended only if a dry heat sterilizer is not available. A shorter cycle at 134°C for three minutes is recommended

due to the deleterious effect it has on the instruments and the instruments must be freed of any residual moisture and wrapped before being subjected to autoclaving. Contaminated orthodontic instruments and bands placed in OMS-ASAP system instrument and band cassettes15 and then subjected to heat sterilization were also efficiently decontaminated of spores and instrument cassettes can be useful adjuncts for sterilization.

PRION PROTECTION - STERILIZATION PROTOCOL FOR ORTHODONTIC PLIERS:

Prions are extremely stable group of infectious agents composed of mainly proteins and are highly resistant to sterilization. They are able to re-fold into different structures, which in turn convert normal protein molecules into abnormal structures. This altered structure is extremely stable and highly resistant to conventional sterilization protocols. Prion elimination requires autoclave cycles at 121°C for 1-hour or 134°C for at least 18 minutes.

The effect of such extreme Prion sterilization protocols on orthodontic ligature cutter were recently evaluated,16 and it was found that surface alterations occurred from the first cycle itself with a blunting of the cutting edges and reduction in the instrument efficiency.

According to Wichelhaus17 exclusive chemical methods are less effective than thermal or physical chemical methods for efficient disinfection of contaminated orthodontic pliers and spraying was not an efficient method which exhibited severe shortcomings. It was also found that heat sterilization of pliers resulted in lesser corrosion than cold disinfection.9 Taking these factors into account, dry heat is the most effective method of orthodontic plier sterilization without compromising the instrument efficiency

MOLAR BANDS STERILIZATION:

Several studies18,19 have reported about the need of effective protocol for sterilization of preformed bands. The guidelines for sterilization of molar bands are:

- Placement in ultrasonic cleaner for five minutes depending on the capacity of the unit.
- Thorough rinsing with distilled water Complete moisture removal by drying with oil-free compressed air.
- Dry heat sterilization at 190°C for six minutes.
- Storage in a dry area free from moisture and humidity.
- The tried in molar bands must be immediately placed in ultrasonic cleaner and should be stored in separate containers if it is not possible to sterilize immediately.
- Autoclaving of plain bands can be done but is not recommended for prewelded bands.
- Chemical sterilization is a secondary choice because of the longer time involved as well as the lack of any indicator for its effectiveness.

ELASTOMERIC CHAINS AND LIGATURES:

Chemicals are not suitable for disinfection of elastomeric ligatures and E-chains because they alter and adversely affect the physical properties of the elastics.20,21 Alcohol wipes are not effective alternatives because they are not effective in the presence of tissue

proteins found in saliva and blood. The best safeguard is to use single patient packs to prevent cross infection. As for E-chains it is best to cut-off some more above that is required and discard the rest.

DISINFECTION OF ALGINATE IMPRESSIONS IN THE DENTAL OFFICE:

- For disinfection of alginate impressions, 1% sodium hypochlorite, sodium dichloroisocyanurate and 2% glutaraldehyde is used. Current recommendations
- requires the alginate impression to be immersed in disinfecting solutions for not more than 10 minutes as prolonged immersion alters the surface characters of the impression material.22
- Guide lines for sterilization of alginate impressions:
- Rinse the saliva from the surface of the impression under running tap water.
- Immerse the impression along with the tray in the disinfectant solution for 10 minutes. Spraying aerosols is not recommended because it will not wet the surface of the impression evenly and poses a health hazard for the operator.
- After 10 minutes thoroughly rinse off the excess

disinfectant from the impression under running tap water and pour the model.

CONCLUSION:

It is a responsibility upon each orthodontist to conduct their practice in a manner that restricts the spread of infection and cross contamination. Asepsis in the dental office is of utmost importance. Sterilization and disinfection significantly decreases the risk of infectious disease for the doctor, the staff and the patient. The oral cavity is the main portal of entry for pathogenic microbes into the body and asepsis of the instruments and hand prevents contamination by way of the respiratory system, blood or saliva.

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CLINICAL EVALUATION OF EFFICACY AND POST OPERATIVE SENSITIVITY OF THREE DIFFERENT IN-OFFICE DENTAL BLEACHING TECHNIQUES

Dr. Heena Fuletra[a], Dr. Kamal Bagda[b], Dr. Suman Makam[c], Dr. Amit Vadher[d]

Abstract :

Aim : To evaluate the alteration of color, color stability, and dental sensitivity on patients undergoing dental bleaching using traditional McInnes solution, 35% hydrogen peroxide gel alone and H2O2 gel activated with light source.

Materials and Methods : 15 patients were selected and randomly divided into three groups (n=5): Group 1 - freshly prepared traditional McInnes solution; Group 2 - 35% Hydrogen Peroxide (H2O2) gel (Opalscence Endo, Ultradent Products, Inc., South Jordan, UT, USA) and Group 3 - 35% H2O2 gel (Opalscence Endo, Ultradent Products, Inc., South Jordan, UT, USA) with LED light (Unicorn Denmart). For all groups, there were two sessions of bleaching, with a one week break between sessions. At each bleaching session, three applications of the bleaching gel, each of 10 minutes with 5 minutes interval between each application were used. Shade evaluation were performed with Vita Classical Shade Guide and digital photographs before and after the first week, first month and three months of the bleaching treatment. Post bleaching tooth sensitivity was measured and recorded.

Results : The in-office dental bleaching treatments of vital teeth with light had better results than that without light but poor colour stability and higher post bleaching tooth sensitivity.

Conclusions : In-office bleaching agent used was effective for the whitening of vital teeth. Use of light activation source for in-office bleaching shows greater colour changes in teeth in comparison to in office bleaching without light.

Key Words : Hydrogen peroxide, in office bleaching, McInnes solution, tooth bleaching.

Introduction

Aesthetic dentistry is characterised primarily by the smile. The smile is the most basic facial expression, and affects the entire face. The goal of dental aesthetics is usually to imitate or even exceed a natural appearance. The smile therefore plays an increasingly important role in emotional expression. Bleaching has been accepted as the least aggressive method for treating discolored teeth[1]. This procedure consists of carbamide or hydrogen peroxide gel applications that can be done in-office or by the patient (at-home/overnight bleaching system)[2]. Even though at-home bleaching system is the most frequently recommended treatment for vital teeth, some patients do not adapt to the technique, because they prefer not to use a bleaching tray or do not like to wait two to three weeks to see the results of their treatment. These patients might request a method that produces more immediate results, the in-office bleaching treatment.[3]

However, the effectiveness of in-office bleaching systems has been controversial. Bleaching appears to be time and concentration dependent.[1] Since the introduction of in-office bleaching treatments, the use of curing lights (including halogen curing lights, plasma arches, LED, LED plus lasers, lasers) has been recommended to accelerate the action of the bleaching gel. In the past, the clinical results obtained with the use of these lights were poor, showing an increase in tooth sensitivity and reduced long-term color stability, especially when the treatment was done in one appointment. Recent developments in in-office bleaching systems that use a chemical catalyst combined with light-cured block-out materials and compounds have resulted in

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decreased tooth sensitivity and enhanced treatment and have demonstrated improved results.[4]

Despite of the fact that many curing lights have been introduced into the dental market for the purpose of accelerating in-office bleaching treatments, no concrete scientific study has proven their effectiveness.[5,6,7] This research clinically evaluated the efficacy and post - operative sensitivity of freshly prepared McInnes solution, 35% hydrogen peroxide paste without light and 35% hydrogen peroxide paste with light.

MATERIALS AND METHODS

Based on the pre established criteria, 15 patients were selected for the study.

The inclusion criterias were -

- Age group between 16-35.
- Good oral hygiene practice.
- Non-smokers and/or did not smoked for 30 days at least prior and are ready to not to smoke during treatment.
- Caries-free vital anterior teeth without restorations.
- No cervical lesion.
- Reasonably free from periodontal disease and had no gingival irritation.

The exclusion criterias were –

- Pregnant or lactating females.
- Previously undergone tooth-whitening procedures until 1 year back.
- Patients with habit of smoking & smokeless tobacco (gutkha, pan, masala).
- Patients with poor periodontal health.
- Patients with only extrinsic stains.

15 patients reporting to the department of Conservative, Aesthetic Dentistry and Endodontics for the treatment of discolored teeth were randomly selected after the fulfillment of selection criteria. After the dental screenings and case history checkups, the whole treatment process was explained to them and only those willing for the treatment were included in this study. The patients were well informed prior to the start of the treatment about the study and the pros and cons of the bleaching and written consent was taken from the patients. Tooth sensitivity was verified with a light air jet over the labial surface of the teeth, with the degree of sensitivity recorded using the following criteria: 1-none, 2-slight, 3-moderate and 4-severe. Shade evaluation was recorded before and after the bleaching treatment using Color Scale Vita Classical Shade Guide.

Before beginning the bleaching treatment, pre-operative photographs and the shade of the upper anterior teeth (canine to canine) of all 15 patients was recorded by two trained volunteers, using the Vita Classic Scale (Vita, Zahnfabrik, Sackingen, Germany). The patients were randomly divided into 3 groups according to the bleaching techniques used. Group 1 – McInnes solution was freshly prepared mixing 5 parts Hcl 36% - 1 ml, 5 parts H_20_2 - 30% - 1 ml and 1 part anesthetic ether - 0.2 ml and applied over the labial surfaces of the teeth using disposable brush. Group 2 – readily available 35% hydrogen peroxide gel (Opalescence Endo, Ultradent Products, Inc., South Jordan, UT, USA) was applied using disposable brush. Group 3 – 35% hydrogen peroxide gel (Opalescence Endo, Ultradent Products, Inc., South Jordan, UT, USA) was applied and light curing was done using LED light (Unicorn Denmart) at a distance of 1 cm from the bleaching gel.

Prior to the application of bleaching agent, oral prophylaxis was performed. The gingival tissue was isolated using a light-cured resin dam (Opaldam, Ultradent Products, Inc., South Jordan, UT, USA) to prevent the bleaching gel from contacting the gingival tissue. To aid in the bleaching process, a labial retractor, plastic suction cup with high suction power and protection glasses (for light activated bleaching group) were used. For all groups, there were two sessions of bleaching, with a one week break between sessions. At each bleaching session, three applications of the bleaching material for 10 minutes were used. 5 minutes interval was kept between the three applications. To prevent tooth sensitivity, GC Tooth Mousse paste was applied immediately after the session for 10 minutes. All the patients were instructed to avoid coffee, tea and cola drinks in between sessions and for 2 weeks after the completion of second session as they may stain the newly bleached teeth. The groups were evaluated based on

the difference in color change before and after the bleaching session, then after 1 week, 1 month and at 3 months from completion of the bleaching treatment. Patient satisfaction level was recorded on follow up.

RESULTS

- In office bleaching with 35% H_2O_2 gel plus light had better results than bleaching with McInnes solution which in turn showed better results than 35% H_2O_2 gel alone when shade was evaluated with Vita Bleached Guide.
- On digital evaluation also, the luminosity of digital photographs of teeth treated with the in office bleaching with light source was more in comparison to bleaching without light source.
- Sensitivity as well as color reversal in teeth treated with light source was much higher in teeth treated without light source.

DISCUSSION

In this clinical study, the in-office treatment using freshly prepared McInnes solution and 35% hydrogen peroxide was used. These bleaching agents were used despite some *in vitro* and *in situ* studies that demonstrated alterations in the dental structure.[8] Other authors provided evidence that these bleaching agents do not cause any type of alteration to the dental structure.[9-11] This divergence is justified by the different methods of study (time of evaluation, bleaching agents used, time of application, immersion of the specimens in artificial saliva between treatments, type of storage, bleaching agent pH, usage of fluoride, etc). When these studies are done under *in vivo* and *in situ* conditions, no alteration of the dental structure was recorded, as saliva prevents demineralization of bleached dental enamel.[12] This study was performed *in vivo* for the purpose of testing the bleaching treatment in a clinical scenario. This evaluation was done specifically on six maxillary anterior teeth (canine to canine). The duration of the applications during the bleaching treatment was standardized.

Bleaching is a decolourisation or whitening process that can occur in solution or on a surface.[13] The colour producing materials in solution or on a surface are typically organic compounds that possess extended conjugated chains of alternating single or double bonds and often include heteroatoms, carbonyl, and phenyl rings in the conjugated system and are often referred to as a chromophore. Bleaching and decolourisation of the chromophore can occur by destroying one or more of the double bonds in the conjugated chain, by cleaving the conjugated chain, or by oxidation of other chemical moieties in the conjugated chain.[13] Hydrogen peroxide oxidises a wide variety of organic and inorganic compounds. The mechanisms of these reactions are varied and dependent on the substrate, the reaction environment, and catalysis.[14] In general, the mechanism of bleaching by hydrogen peroxide is not well understood and it can form a number of different active oxygen species depending on reaction conditions, including temperature, pH, light and presence of transition metals.[14] Considering the available literature, evidence points towards the initial diffusion of peroxide into and through the enamel to reachthe enamel dentine junction and dentine regions. Indeed, in vitro experiments by a number of authors have demonstrated the penetration of low levels of peroxide into the pulp chambers of extracted teeth after exposure times of 15– 30 min from a range of peroxide products and solutions.[15,16] As peroxide diffuses into the tooth, it can react with organic coloured materials found within the tooth structures leading to a reduction in colour. This is particularly evident within dentine as demonstrated by McCaslin et al.[17] who showed, using hemi-sectioned human teeth mounted on glass slides, that following external bleaching with carbamide peroxide, colour changes occurred throughout the dentine.

Under photochemically initiated reactions using light or lasers, the chemical reaction of formation of hydroxyl radicals from hydrogen peroxide has beenshown to increase [18] and results in more whitened teeth as seen in group 3 of this study. The presence of 36% hydrochloric acid in McInnes solution etches the enamel and makes the surface rough allowing easy penetration and diffusion of peroxide into the teeth resulting in more whitened teeth as in group 1 than in group 2 in which 35% H_2O_2 gel was used alone.

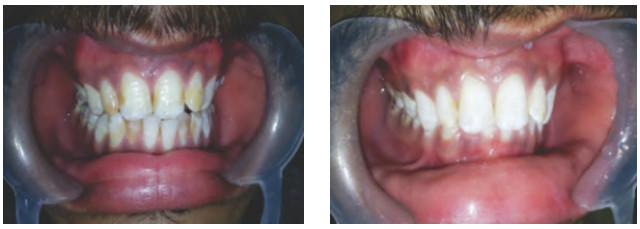
In this clinical study, the bleaching was performed with different techniques in two in-office sessions, with six

applications of the bleaching agent (three applications at each appointment) conducted in three groups. This application technique simplified comparison of the results to other studies.[10,19-21] Tooth sensitivity was measured and recorded using the following criteria: none, slight, moderate and severe, to simplify the evaluation. This differed from the study by Zekonis and others.[22] Tooth sensitivity was found highest in group 3 and lowest in group 2. This can be attributed to the use of light and heat sources, which led to higher pulpal temperature[4] in group 3. For group 1, tooth sensitivity probably occured because of higher penetration and diffusion of peroxide due to etched enamel. Tooth sensitivity occurred immediately following bleaching, but a higher degree of sensitivity was recorded after the second bleaching session. The color scale was used for the visual and digital evaluation. This method is the most common, as it is a quick, simple procedure and has been used successfully in many studies.[23-26] The shade selection process depends on numerous factors, such as source of light, tooth to be evaluated, evaluator experience and standardization and many other factors.[27] Immediately after bleaching, group 3 showed maximum whitening of teeth while group 2 showed minimum whitening. But shade reversal was maximum with group 3 and minimum with group 2. The current study was done in a single room with artificial lighting and two experienced, qualified evaluators, for the purpose of preventing any discrepancy in choosing the correct shade.

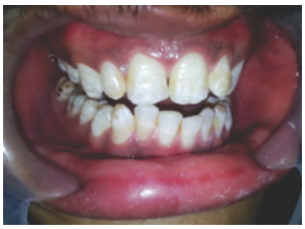
CONCLUSION

Within the limitations of this study, it can be concluded that in office bleaching agent used was effective for the whitening of vital teeth. Use of light activation source for in-office bleaching shows greater colour changes in teeth, post bleaching and during follow up as well, in comparison to in office bleaching without light. Tooth sensitivity was greater in patients who underwent in-office bleaching with light.

FIGURE LEGENDS

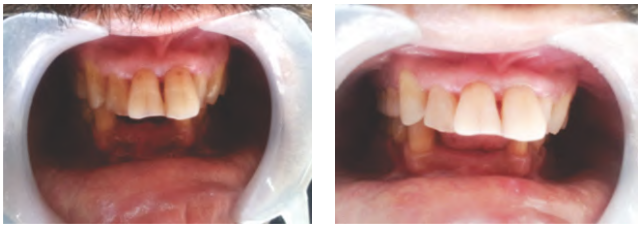


Pre-operative | Post-operative after 2nd session



Follow up after 3 months

Figure 1: In office bleaching with McInnes solution.



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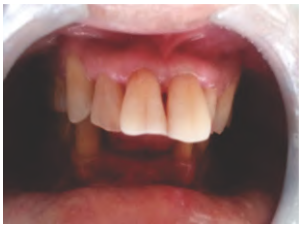
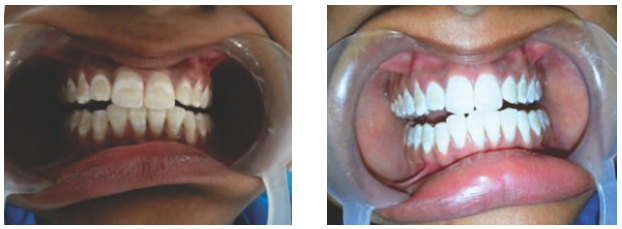
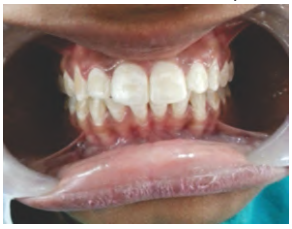


Follow up after 3 months

Figure 2: In office bleaching with 35% hydrogen peroxide gel.



Pre-operative | Post-operative after 2nd session



Follow up after 3 months

Figure 3: In office bleaching with 35% hydrogen peroxide gel with LED light.

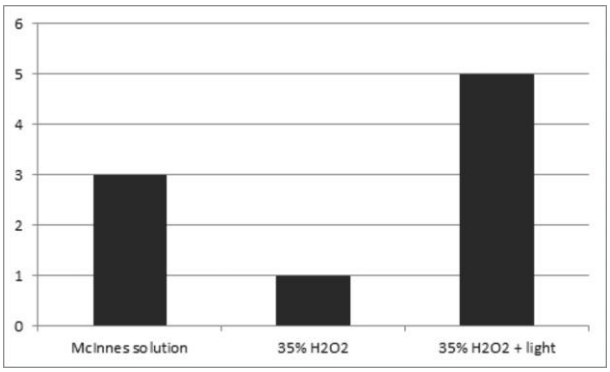


Figure 4: Graph showing tooth sensitivity after bleaching in all three groups.

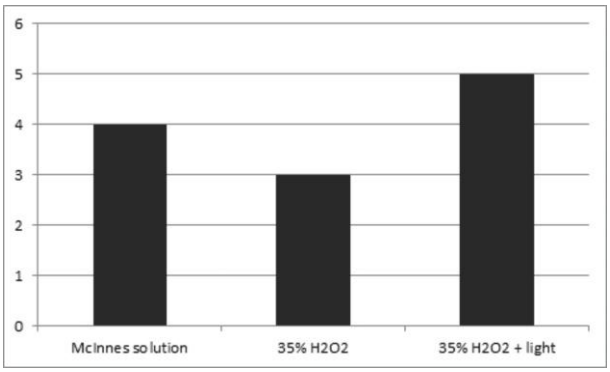


Figure 5: Graph showing shade reversal during follow up in all three groups.

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A COMPARATIVE ASSESSMENT OF MECHANICAL PROPERTIES OF VARIOUS INITIAL ALIGNING WIRES IN BENDING

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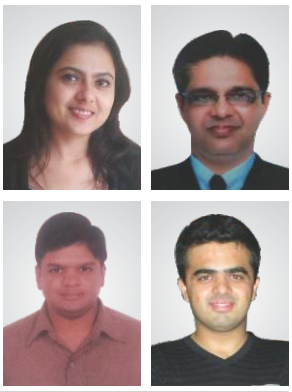
Abstract :

Pathogenic microbes may be transmitted directly from the dentist to the patient or from the patient to the doctor, and indirectly from patient-to-patient. The latter may occur via contaminated instruments or surfaces, and is referred to as cross-contamination. This presents an enormous challenge in the current scenario as it has been proved that blood and saliva are high-risk sources of contracting hepatitis B, human immunodeficiency virus and herpes. In addition to that mouth is the reservoir of several pathogens which can be easily transmitted from patient-to-patient or to the doctor. Effective sterilization and disinfection techniques must be rigidly followed as per the accepted protocols to prevent the incidence of cross infections in the dental office.



Key Words : Sterilization, orthodontic instruments.

A comparative assessment of mechanical properties of various initial aligning wires in bending.

An ideal aligning wire should exhibit mechanical properties such as constant force over long activation range, more resistant to permanent deformation, better shape memory, less mechanical hysteresis and precise and consistent transformation temperature[1].

Introduction of Nitinol by G. F. Andreason in 1971was a significant step towards the utilization of various alloy wires for achieving proper alignment. The Niti wires exhibited low modulus of elasticity, high strength and extreme working range[2]. This was followed by introduction of Chinese Niti by Burstone and co-workers[3] that had better springback, less stiffness than conventional Niti. Japanese Niti developed by Miura[4] had property of super elasticity and delayed permanent deformation. Tonner[5], Filleul[6] found that loading and unloading curves of Niti were closely related to temperature[5]. Fisher[7] showed that Copper Niti exhibited 70% lighter and more constant force than standard Niti.

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Thus a study was done to compare the load versus deflection characteristic, super elastic ratios and mechanical hysteresis of various initial aligning wires in three point bending test at 37°C.

Materials and methods:

Commonly used aligning archwires such as multistranded Stainless steel and super elastic Niti alloy wires in round, square and rectangular configuration were tested in the study.

They were grouped as:

Group 1- Round wires. It included

0.016" Cu Niti Aft 35°C(Ormco Corp),

0.016" Sentalloy-Medium force (GAC),

0.016"x0.016" Neosentalloy F- 80(GAC),

0.016" co-axial stainless steel (Ortho Organisers).

Group 2- Rectangular wires. It included

0.016"x0.022" Cu Niti Aft 35°C(Ormco Corp),

0.016"x0.022" Neosentalloy F-160 (GAC),

0.016"x0.022" Neosentalloy F- 80(GAC),

0.016"x0.022" braided stainless steel (Ortho Organisers).

Ten wires of each group were studied.

Three point bending test:

This test was done using Instron Universal Testing machine (Instron Corp. Mass) to determine load deflection characteristics of different archwires. Specially designed brackets mount having movable upper hook shaped member with a diameter of 5mm and stationary lower member was used. The lower member had four 0.018"x0.025" standard edgewise twin brackets bonded using cynoacrylate adhesive (superglue, Alpha Techno, Japan), two were oriented in edgewise plane while other two in flat wise plane. The interbracket distance was adjusted such that the mid axes of the two brackets were 14 mm apart. This was done because the loading rod comes exactly in center of two brackets making the testing span of 7 mm on either side. This mimics the oral condition. During testing the wires were ligated in the bracket using elastic modules (Ormco Corp.) The upper member moved upwards at a speed of 2mm/min up to 3mm thus deflecting the wire. It was again lowered to original position maintaining the same speed. Loading and unloading forces were registered by load cell at interval of 0.3mm deflection. Mean values of load for each group were plotted against displacement on X-Y coordinate system. As the austenitic finish (Aft) temperature of thermodynamic Niti wires was 35°C, the test was carried out at 37°C.

For rectangular wires, flat wise testing simulates occluso-gingival condition, whereas edgewise testing simulates labio-lingual deflection.

Parameters like super elasticity ratio (ratio of slope of final part of deactivation curve to slope of plateau), deflection of wire (in mm) at beginning and end of plateau and minimal force level at the end of super elastic plateau were calculated. Mechanical hysteresis was considered as the difference between the loading and unloading force. Mean and standard deviation were used for statistical analysis.

Results:

A- Comparison of loading and unloading forces

Group 1

The load values of coaxial Stainless steel were significantly lower than Cu Niti, Sentalloy, and Neosentalloy wires. At deflection of 3.0mm the load values were 527.17 gm for Cu Niti, 553.68gm for round Sentalloy, 583.21gm for square Neosentalloy wires and 322.47 gm for steel. (Table no 1) in unloading curve the mean force value at 1.5 mm were 174.32 gm for Cu Niti, 191.25 gm for Sentalloy and 188.92 gm foe Neosentalloy and 097.48gm for steel.

Group 2

In edgewise mode, the load values for braided steel wire was least at 3mm deflection with 661.23 gm followed by 735.45gm for Cu Niti, 867.77 gm for Neosentalloy F80 and lastly 1040 gm for Neosentalloy F160. During unloading at 1.5 mm the values were 172.31 gm for steel, 223.15 for Neosentalloy F 80, 237.95 gm for Cu Niti and 317.27 gm for Neosentalloy F 160.

In flat wise mode the force value was least for Neosentalloy F 80 (1111.21 gm) followed by Neosentalloy F 160(1181.53 gm), Cu Niti (1333.51 gm) and lastly braided steel wire (1510.55 gm). The unloading force at 1.5 mm were 96.47 gm for F80 wire, 167.44 gm for F160 wire, 185.56 gm for braided wire and 260.90gm for Cu Niti wire.

A distinct plateau was seen in Cu Niti and Neosentalloy F160 from 2.4 mm up to 0.3 mm deflection, up to 0.6 mm for Neosentalloy F80. The Stainless steel wire had undergone permanent deformation thereby delivering only 7gm force at 0.6mm deflection.

B- Super elasticity:

In Group 1 the super elastic ratio of Cu Niti was maximum-13.57, followed by 3.92 for Sentalloy, 3.24 for Neosentalloy and lastly 2.7 for coaxial steel wire.

In group 2 variation was seen in edgewise mode with ratio as follows: 4.86 for Cu Niti, 4.53 for Neosentalloy F160, 3.81 for Neosentalloy F80 and 0.61 for steel.

In Flat wise mode Cu Niti showed higher super elasticity ratio- 55.67 as compared to 20.8 for Neosentalloy F160, 11.88 for Neosentalloy F80 and 6.6 for steel. Other parameters indicate the length of super elastic plateau was larger for Cu Niti wires.

C- Mechanical hysteresis

There was a fluctuating trend seen after evaluation and comparison of mechanical hysteresis. The values of maximum hysteresis seen over a span of 0 to 3 mm deflection for group 1 were 327.2 gm for Cu Niti, 243.7 gm for Sentalloy, 293.62 gm for square Neosentalloy and 183.50 gm for coaxial wire. (Table no 5 graph no 4)

Maximum hysteresis for group 2 in edgewise mode were 376.7 gm for Cu Niti, 554.8 gm for Neosentalloy F160, 499.16 gm for Neosentalloy F80 and 332.89 gm for braided steel.

In flat wise mode the values of hysteresis were 958.03 gm for Cu Niti, 803gm for Neosentalloy F160, 779.53 gm for Neosentalloy F80 and 1234 gm for braided steel.

Mechanical Hysteresis in loading and unloading forces for rectangular wires in Edgewise mode

Deflection (mm)	Cu Niti	Neosentalloy F80	Neosentalloy F 160	Braided Steel
0.3	0.133806	0.216102	0.30804875	0.119025625
0.6	0.207545	0.313753	0.364253125	0.168789375
0.9	0.281818	0.37315	0.378179375	0.221306875
1.2	0.308042	0.433216	0.41274875	0.270136875
1.5	0.326506	0.471979	0.438921875	0.296968125
1.8	0.332823	0.465603	0.489923125	0.322980625
2.1	0.355646	0.482378	0.499159375	0.332885625
2.4	0.338047	0.449487	0.46207625	0.3317075
2.7	0.194447	0.396526	0.365265625	0.297649375
3	0	0	0	0

Mechanical Hysteresis in loading and unloading forces in rectangular wires for Flatwise mode

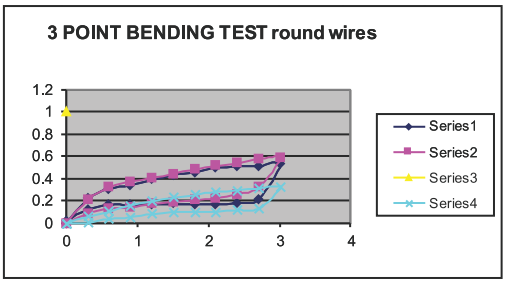
Deflection (mm)	Cu Niti	Neosentalloy F 160	Neosentalloy F80	Braided Steel
0	0	0	0	0
0.3	0.133045625	0.24093375	0.24679875	0.118450625
0.6	0.403855625	0.40435375	0.45413625	0.24328375
0.9	0.49210875	0.523819375	0.56122875	0.3354
1.2	0.58321375	0.595463125	0.62406375	0.44009
1.5	0.632715625	0.622474375	0.688915	0.57063375
1.8	0.6996575	0.693610625	0.7241875	0.729688125
2.1	0.777830625	0.7479775	0.76826625	0.864468125
2.4	0.861720625	0.802691875	0.77952625	1.015570625
2.7	0.95802875	0.803003125	0.73109125	1.234536875
3	0	0	0	0

Mechanical Hysteresis in loading and unloading forces in round wires

Deflection (mm)	0.016" Cu Niti	0.016" Sentalloy	0.016"x0.016"Neosentalloy	0.016" coaxial Steel
0	0	0	0	0
0.3	0.093623125	0.11595875	0.12131125	0.0520275
0.6	0.1406325	0.176945	0.185905625	0.070255
0.9	0.175875625	0.20067	0.227177563	0.10492
1.2	0.222440625	0.21576875	0.235899375	0.11292
1.5	0.262595	0.23625875	0.2531875	0.13357625
1.8	0.28474	0.24334125	0.27432625	0.149340625
2.1	0.3208025	0.24370375	0.293618125	0.180366875
2.4	0.327294375	0.23327625	0.276340625	0.174494375
2.7	0.292780625	0.1999975	0.249830625	0.1835
3	0	0	0	0

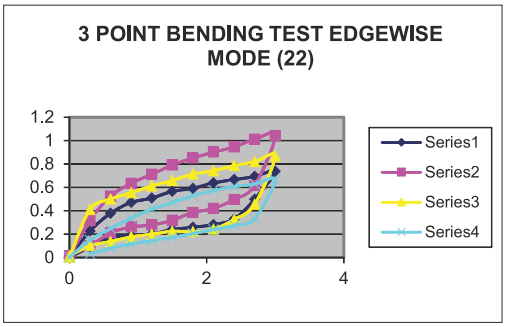
Loading and unloading forces of group 1 wires in three point bending test

deflection (mm)	0.016" CUNITI MEAN	0.016" CUNITI S.D.	0.016" Sentalloy MEAN	0.016" Sentalloy S.D.	0.016"x.0016" Neosentalloy MEAN	0.016"x.0016" Neosentalloy S.D.	0.016"Coaxial Steel MEAN	0.016"Coaxial Steel S.D.
0	0	0	0	0	0	0	0	0
0.3	0.218616875	0.001149	0.1966375	0.013756	0.208719	0.004586	0.057212	0.003437
0.6	0.303680625	0.002293	0.29872625	0.012343	0.322305	0.008027	0.10738	0
0.9	0.33992375	0.006874	0.369455	0.014264	0.370796	0.016049	0.156536	0.003441
1.2	0.388749375	0.012608	0.3963	0.006878	0.408041	0.018338	0.195629	0.002293
1.5	0.43138	0.014892	0.42750875	0.007057	0.442104	0.014897	0.231053	0.008044
1.8	0.455538125	0.008791	0.46246125	0.003024	0.481698	0.019486	0.252187	0.010302
2.1	0.4951225	0.001144	0.49168	0.001762	0.516263	0.021775	0.283213	0.009167
2.4	0.505020625	0.002293	0.51744	0.004585	0.538914	0.004581	0.293617	0.011464
2.7	0.508713125	0.009167	0.53556125	0.003468	0.572642	0.003437	0.313192	0.000867
3	0.527166875	0.011464	0.55368125	0.004586	0.583211	0.004586	0.322471	0.016045
2.7	0.2159325	0.001144	0.33556375	0.022462	0.322811	0.004586	0.129692	0.003437
2.4	0.17772625	0.005696	0.28416375	0.015871	0.262574	0.024072	0.119123	0.01146
2.1	0.16630875	0.000128	0.24797625	0.004827	0.222644	0.026365	0.102846	0.003441
1.8	0.168785	0.002288	0.21912	0.006138	0.207371	0.004586	0.102846	0.003441
1.5	0.17432	0.010315	0.19125	0.010324	0.188917	0.011464	0.097476	0.003441
1.2	0.170798125	0.006878	0.18053125	0.01104	0.172141	0.016045	0.082709	0.012608
0.9	0.164048125	0.010772	0.168785	0.002288	0.143618	0.009171	0.051616	0.002024
0.6	0.163048125	0.009816	0.12178125	0.015803	0.136399	0.012608	0.037125	0.000444
0.3	0.12499375	0.017189	0.08067875	0.008554	0.087408	0.001144	0.005184	0.002797
0	0.0227075	0.003596	0	0	0	0	0	0



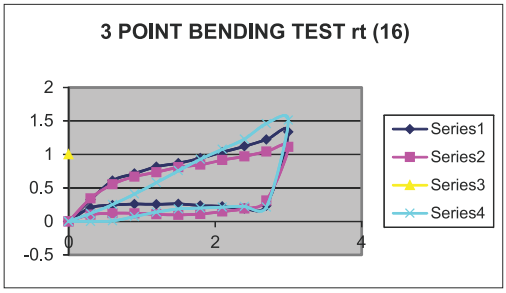
Loading and unloading forces(Kg) of rectengular wires in edgewise mode

Deflection (mm)	Cu NiTi MEAN	Cu NiTi S.D.	Neosentalloy F160 MEAN	Neosentalloy F160 S.D.	Neosentalloy F 80 MEAN	Neosentalloy F 80 S.D.	Bradided steel MEAN	Bradided steel S.D.
0	0	0	0	0	0	0	0	0
0.3	0.224445	0.010691	0.314420625	0.002293	0.408380625	0.002293	0.147810625	0.008023
0.6	0.37625375	0.006259	0.522974375	0.005734	0.498643125	0.032094	0.24629875	0.004586
0.9	0.468963125	0.000875	0.633209375	0.002293	0.552839375	0.008023	0.335229375	0.002293
1.2	0.507245	0.002767	0.7105575	0.021775	0.61022125	0.014901	0.41207625	0.00918
1.5	0.56446	0.008539	0.789249375	0.018338	0.6566975	0.01146	0.469279375	0.012608
1.8	0.59040875	0.004665	0.849651875	0.027509	0.713073125	0.011464	0.525994375	0.01032
2.1	0.6364975	0.015249	0.90032125	0.025216	0.740759375	0.008023	0.571970625	0.008023
2.4	0.6656425	0.009444	0.944278125	0.013752	0.7850525	0.001144	0.605021875	0.006878
2.7	0.691905625	0.005606	1.01035625	0.006874	0.817603125	0.001149	0.628009375	0.008023
3	0.735454375	0.010516	1.04025	0.005123	0.86777125	0.004586	0.66123125	0.014901
2.7	0.49745875	0.011503	0.613830625	0.001336	0.4523375	0.009171	0.33036	0.010315
2.4	0.327595875	0.006388	0.49479125	0.014901	0.32297625	0.003441	0.273314375	0.005734
2.1	0.28085125	0.004295	0.417943125	0.021779	0.2416	0	0.239085	0.008027
1.8	0.257585625	0.00909	0.38404875	0.046991	0.217775625	0.016049	0.20301375	0.006874
1.5	0.23795375	0.005081	0.31727	0.030946	0.22315	0.020631	0.17231125	0.00573
1.2	0.199203125	0.00067	0.27734125	0.014901	0.1974725	0.019486	0.141939375	0.002293
0.9	0.187135	0.003791	0.260059375	0.002293	0.17466	0.010315	0.1139225	0.001144
0.6	0.16870875	0.004995	0.20922125	0.046991	0.13439	0.010315	0.077509375	0.002293
0.3	0.090639375	0.009252	0.09831875	0.025216	0.100331875	0.006878	0.028785	0.000938
0	0	0	0.0149275	0.001144	0.0105	0.015556		



Loading and unloading forces(Kg) of rectengular wires in flatwise mode

	Cu NiTi		Neosentalloy F160		Neosentalloy F 80		Bradided steel	
Deflection (mm)	MEAN	S.D.	MEAN	S.D.	MEAN	S.D.	MEAN	S.D.
0	0	0	0	0	0	0	0	0
0.3	0.32246875	0.002293	0.3796875	0.019486	0.343265	0.002271	0.118450625	0.002293
0.6	0.607034375	0.05731	0.56693125	0.00573	0.5536975	0.022859	0.25049625	0.003441
0.9	0.713240625	0.09513	0.691261875	0.027509	0.6666175	0.037193	0.407038125	0.006878
1.2	0.81559625	0.115765	0.7697825	0.050432	0.73331375	0.011843	0.57767125	0.00573
1.5	0.868274375	0.108887	0.804011875	0.027509	0.8081675	0.006729	0.756194375	0.014897
1.8	0.941763125	0.04241	0.880183125	0.052725	0.8441425	0.015322	0.927666875	0.019482
2.1	1.03235	0.019469	0.936558125	0.034383	0.91346	0.016183	1.07685	0.016054
2.4	1.11943125	0.018316	1.00117625	0.044719	0.96997	0.005562	1.22798125	0.001153
2.7	1.218925	0.008027	1.077625	0.027496	1.04131	0.055405	1.45801875	0.03437
3	1.3335125	0.013748	1.181525	0.020665	1.1112125	0.043576	1.51055	0.051576
2.7	0.2323725	0.019486	0.274821875	0.006878	0.31021875	0.013072	0.212381875	0.020609
2.4	0.189423125	0.001149	0.174319375	0.008023	0.19044375	0.006584	0.223481875	0.013752
2.1	0.221131875	0.006878	0.1625775	0.001144	0.14519375	0.01611	0.212410625	0.002293
1.8	0.23555875	0.004586	0.13875375	0.003441	0.10925	0.015427	0.19797875	0.004586
1.5	0.26089625	0.024072	0.1674425	0.01146	0.09646625	0.014076	0.185560625	0.002293
1.2	0.254519375	0.012608	0.1865725	0.009171	0.10538875	0.005633	0.13758125	0.004586
0.9	0.257710625	0.018338	0.1815375	0.01146	0.1192525	0.014254	0.071638125	0.003437
0.6	0.242105625	0.005734	0.188580625	0.022923	0.119955	0.034254	0.0072125	0.001421
0.3	0.20317875	0.014901	0.198484375	0.026365	0.09956125	0.038418	0	
0	0	0	0	0	0	0	0	



Discussion

Three point bending test accurately differentiate the wires that do not possess super-elastic features. Also the test resembles the applied force in oral cavity when normal crowding is present and there is minimum 2 mm deflection of wire[8]. In the test, loading and unloading forces of coaxial steel wire were lower and moreover linear which is not the characteristic of super-elastic wires. They can be used for alignment provided the clinician has knowledge of behavior of coaxial steel wires when using as substitute for Niti wires[9].

The load in flat wise plane were greater than edgewise plane, that is in unison with many other studies[10], this can be because of the bracket slot clearance and interaction of bracket and wire geometry or the uneven distribution of strain hardening within the wire resulting from manufacturing process. Super-elastic wires do not follow the Hooke's law i.e. they show non-linear loading and unloading. The ratio of final part of super-elastic curve to plateau slope gives the super-elastic tendency. Stainless steel or work hardened Niti has a ratio of 1 where as when the ratio is above 2, the material has super-elastic tendency. An ideal super-elastic wire would have ratio of 8 and above[11]. Our study shows that round Cu Niti wire is highly super-elastic.

All the rectangular wires in flat wise mode also show high super-elastic ratios this correlates with the findings of previous researchers[11].

The last part of deactivation curve where the wire is austenitic phase is linear, suggesting that the super-elastic properties cease during final deactivation. This suggests that the aligning wire should have a longer plateau. All our wires showed super-elastic properties upto 0.3mm thus useful in final alignment also. Some researchers[11, 5,12] have suggested that until manufacturers produce wires with plateau upto 0.2mm it is desirable to complete the aligning by increasing the wire slot.

The vertical distance between the activation and deactivation curve is combined effect of mechanical hysteresis of the material and the friction between the wire and the bracket[11]. Ideally hysteresis should be zero, but this is not seen practically. There is slight variation in the force delivered during loading and unloading[13]. In activation mode the friction increases the measured force, while in deactivation mode the friction decreases the effective force. The amount of hysteresis is calculated to evaluate and compare the difference between loading and unloading force. It is least for stainless steel followed by Cu Niti for group 1. For group 2 in edgewise mode the hysteresis was least for braided steel wire followed by Cu Niti. In flat wise mode there was high variation in the hysteresis of different super-elastic wires. It was lowest for Cu Niti followed by Medium force Neosentalloy, Light force Neosentalloy and lastly braided steel wire. This suggests that Cu Niti wire would exert same amount of force all through the aligning process. It would also need less reactivation (religation) reducing the overall chair side time during alignment.

Conclusion

The results indicate that Cu Niti wire possessed greater super-elastic properties generating a more constant force over long activation spans and less mechanical hysteresis than other wires. Multistranded steel wires had lower force values than other Niti wires. Thus they can be used in initial phase of treatment but for the final alignment Niti wires are mandatory.

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