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Conservative and Endodontic Society of Kerala (CAESOK)

The CAESOK came into being as an organization on the 28th September 2002. It was the like minded discussions among a few Endodontists like Dr. Shiju Cherian, Dr. John Joseph, Dr. A.K. George, Dr. Rajkrishnan and Dr. N.O. Varghese during the dental conferences and meetings that led to the idea of forming a society of Endodontists from Kerala to share their views and aspirations. These informal chats were followed up with numerous telephonic discussions. With the sincere support of Dr. C.V. Pradeep, Dr. V.I. Paul, Dr. Gene Jacob and Dr. Sivapriyan, the foundations were laid, with the first meeting of about 60-70 Endodontists from various parts of Kerala taking place at Hotel Renaissance, Ernakulam on 3rd February 2002.

The name of the society, CAESOK, was suggested by Dr. N.O. Varghese and the emblem for the society was designed in the artistic hands of Dr. Ajith Thomas.

With Dr. Kunjamma Thomas and Dr. Baby James joining the aforementioned team of dentists, these pioneers formed the group of office bearers at the official inauguration of the society by the Hon. Justice M. Ramachandran on the 28th September 2002 held at Riviera Suites, Kochi.

Since its inception the society holds a midterm conference and an annual conference and family meet every year to further strengthen the bond of friendship and fellowship as individuals and as a family.

OFFICE BEARERS

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- Dr. Kunjamma Thomas
- Dr. Mathew Varghese
- Dr. Mohammed Sadique
- Dr. Satheesh Kumar
- Dr. Varghese NO
- Dr. Pradeep C V
- Dr. Pramod Kumar AV
- Dr. Prathap MS
- Dr. Rajesh Pillai
- Dr. Robin Theruvil
- Dr. Thajuraj PK
Dear friends,

Warm greetings from the President’s office!

JCAESOK, the culmination of our dreams for academic excellence, has reached the next milestone, the 3rd issue. The efforts to bring it forward to international standards can be seen on each page, and as always, our editors have outdone themselves. The quality of articles has gone up appreciably and advertisements have been restricted to a minimum. Let us all join in congratulating the editorial team for their commendable work.

As we tread on our 11th year as a fraternity, there are bright hopes. The membership count has crossed 200, which is testimonial to the commitment and dedication of the office-bearers. However, the progress of CAESOK itself is limited to its members, viz. all of us. We need to be more forthcoming with our suggestions and opinions to enable the office to serve the association better. Please do respond to call letters and intimations in a timely fashion and help maintain the pace of development. All feedback, positive as well as negative, is welcome.

The 10th mid-term conference and PG convention is around the corner, giving us an opportunity to get together and interact in an excellent academic environment, in Kochi. I look forward to meeting you all there.

I expect the very enthusiasm that has sustained CAESOK all along, from all the members, in the days ahead.

Jai CAESOK!

Dr. Baby James
President, CAESOK
Dear Colleagues,

Seasons best greetings from my side. It is a pleasure for me to address you all through this journal. I have received almost a dozen telephone calls appreciating the quality and standard of the journal JCAESOK, that too not from Kerala, but from different parts of the country.

When I was pursuing my post graduation in Manipal my mentor Dr K.S Bhatt used to tell a saying about "Vidhyabhyasam". The first part of the word "Vidya" is all about what you gather at the Dental school and earns you the degree and qualification. The second part of the word is about your perception of the concepts that gradually leads to a particular way of practicing the mastered science - Vidya. This slow evolution of you as a true professional is "Abyasam". Ironically these days Vidya remains confined to some individuals and Abyasam is pushed to another extreme by some. The confluence of Vidya and Abyasam is rarely achieved. Different schemes of "Abyasams" are developed by many dental professional in order to excel and becomes a matter of existence for some professionals. This would surely lead to unhealthy competition among contemporaries and devaluation of the profession in the eyes of the general public. Let us change this trend.

Peer group discussion and interaction of likeminded professionals irrespective of age or geographical demarcation leads to emergence of a strong professional community. CAESOK was formed with this objective and has contributed a lot to the professional upliftment of Conservative Dentistry and Endodontics in "Gods own country". With pride, I can declare that CAESOK has stood for its objectives for which it was formed way back in 2002. With the start of publication of our journal we continue to contribute for research and our fraternity members have a wonderful journal in hand to read and contribute. My appreciation for the entire editorial team with Dr Ganesh at the helm.

Critical analysis of scientific literature is one of the most important requirements for a speciality to grow. But presently it seems most of the specialist dental professional is either too busy to read and criticize the literature or life is too good to be wasted on critical thought and dissemination of knowledge. My sincere request to all our fellow members to contribute thought provoking research articles and case reports. This journal as an avenue can be utilized for clinicians and academicians as a stepping stone for research based method of teaching as well as learning and in fact will help to instil a sense of confidence for fellow members to publish in journals of international repute.

Jai CAESOK, Jai Hind

Yours sincerely.

Dr. Prasanth Dhanapal
Hon. Secretary, CAESOK
Editorial

"Whether you think you can or that you can't, you're usually right."

~ Henry Ford ~

Proper documentation is a critical area where we are far behind our compatriots in developed countries. Cost of equipment, time taken and relatively more patient turnover are the most commonly cited reasons for not doing so. Maintaining proper case records, patient details and radiographs of follow-ups can help in treatment outcomes and in devising new protocols for treatment. We Endodontists should take the initiative in this area as more often than not, our treatment needs longer follow-ups to decide on the success or failure. Not having proper radiographs/records of earlier treatment have often lead to wrong diagnosis and treatment. It can also be very useful when legal and ethical issues are to be addressed. The initial investment will be more than useful in the long run.

The increase in the number of articles being sent for publication to JCaesok is very encouraging. The highlight of this issue is a clinical article by Dr Arvind Shenoy on Porcelain Laminate Veneers, which will be of immense value to both post graduate students and clinicians alike.

CAESOK will start its activities for the year 2012 with its PG Convention in AMRITA School of Dental Sciences, Kochi in July 2012. It's been almost one year since the highly successful Bangkok sojourn and the time is ripe for a get together.

Looking forward to meeting all of you at Kochi

Dr. Ganesh C.
Editor in Chief
Professor,
Dept. of Conservative Dentistry and Endodontics,
Sri Sankara Dental College,
Varkala, Trivandrum.
Porcelain Laminate Veneers: Making the right choices

* Arvind Shenoy, ** Roopa Babannavar

Abstract

Porcelain veneers are steadily increasing in popularity among today’s patients and dental practitioners for conservative restoration of unaesthetic anterior teeth. They are resin-bonded to the underlying tooth and provide a conservative method of improving appearance or modifying contour, without resorting to a full coverage crown. Availability of various materials and techniques of fabrication in market creates certain degree of confusion amongst clinicians. In this brief review, we will discuss the materials available for veneers, tooth preparation and fabrication techniques.

Introduction

The concept of porcelain veneers is not entirely new. In the 1930’s, Dr. Charles Pincus created early porcelain veneers in order to improve the appearance of the teeth of movie stars. Conditions were not ideal. The procedure was not available to the layperson, and he was required to use denture adhesive to hold the teeth in place. In 1938, Dr Charles Pincus [1] described a technique in which porcelain veneers were retained by a denture adhesive during cinematic filming. The fragile restorations had to be removed after filming because no adhesive system existed at that time to permanently attach them. Simonsen and Calamia [2] as well as Horn [3] reactivated the interest in porcelain veneers by introducing special acid etching procedures that substantially improved the long term porcelain veneer retention. They demonstrated that the bond strength of a hydrofluoric acid-etched and silanated veneer to the luting resin composite is routinely greater than the bond strength of the same luting resin to the etched enamel surface [4]. More recently, the porcelain veneer exploded onto the dental scene in the early 1980’s, preceded by the emergence of the direct composite veneer. (5) The porcelain veneer has become one of the most successful developments in dentistry.

Indications and Contraindications

Porcelain veneers are indirect restorations that represent an excellent treatment option for esthetically compromised teeth and can provide many years of service when properly planned and placed. The porcelain veneer is a conservative alternative to full coverage crowns.

Porcelain veneers are primarily indicated for dark, esthetically compromised anterior teeth. They may be used to treat enamel hypoplasia, tooth discoloration, intrinsic stains, fractured teeth, diastemas and anatomically malformed teeth. They also may be considered on worn mandibular incisors when conservatively restoring anterior guidance. (6) The ideal cases which we would want to place the veneers are when the teeth are aligned perfectly on the dental arch and maintaining their original facial volumes which means that the facial structures of the teeth is not worn as it happens by aging. That means, we exactly need to remove the tooth structure equivalent to the thickness of the veneer that we will be placing on the tooth itself. [7]

A porcelain laminate veneer is one of the most conservative and aesthetic techniques that we can apply when restoring the human dentition. Since their development 25 years ago, interpreting the indications and applying the correct techniques has been key to providing their longevity. Long term (15- and 20-year) retrospective studies indicated that the success rates of veneers are as high as 94% to 95% percent. (8,9) Tooth preparation is one of the most important considerations in this technique. Bonding to enamel rather than dentin provides the best/strongest bond values when we want to bond porcelain to tooth structure.

Pascal Magne divided the indications into 3 principal groups

Type I- tooth discoloration resistant to bleaching procedure
  IA- tetracycline discoloration of degree III & IV
  IB- no response to external/ internal bleaching

Type II- the need for major morphologic modification in anterior teeth
  IIA- conoid teeth
  IIB- diastemata & interdental triangles to be closed
  IIC- augmentation of incisal length & prominence

Type III- extensive restoration of compromised anterior teeth
  IIIA- extensive coronal fracture
  IIIB- extensive loss of enamel by resorption & wear
  IIIC- generalized congenital & acquired malformation

There are several contraindications for porcelain veneers. First, teeth that are crowded should not be treated

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with porcelain veneers, but rather misaligned teeth primarily should be treated with orthodontics. This is because correction of severely rotated teeth generally requires removal of all enamel in order to place the restoration in line with the remaining teeth. This leaves only dentin remaining for bonding to the porcelain veneers, a situation that is contraindicated for the reason that an enamel-resin bond is ideal for porcelain veneers. Dentin-porcelain bond strength is much weaker than enamel-porcelain bond strength, and veneers bonded primarily to dentin will be less durable over time and will tend to fail faster. Porcelain veneers rely strongly on their bond to enamel and any enamel irregularities or deficiencies may affect bond strength. Placement of porcelain veneers is contraindicated on any tooth with greater than 30% exposed dentin after preparation. Also, teeth with large restorations are not ideal candidates for porcelain veneers. These teeth may need to be treated with full crown coverage instead. (10)

Restoration failures have occurred and are often due to faulty occlusion. In order to assure that the porcelain veneers last as long as possible they should only be considered when occlusion is close to ideal. That is, there must be canine guidance rather than group function with no interferences in any of the excursive movements. The muscles of mastication and temporomandibular joint should be without pathology or malposition, and stops should be present on all teeth. (11) If a moderate deviation from ideal occlusion presents, one may want to consider full coverage restorations.

Finally, porcelain veneers may be contraindicated in patients with periodontal disease for several reasons. (12) First, there may be increased soft tissue irritation due to the gingival extensions of the veneers. Second, porcelain has increased surface roughness in comparison to natural tooth structure. This leads to an increased amount of plaque around the gingival margins and further irritation of unhealthy gingival tissue. It is vital that patients maintain good oral hygiene habits in order to increase the veneers’ longevity, marginal integrity, and to prevent marginal staining. (12)

The success of ceramic veneers can be attributed to great attention to detail in the following areas: (1) planning the case, (2) conservative (enamel saving) preparation of teeth, (3) proper selection of ceramics to use, (4) proper selection of the materials and methods of cementation of these restorations, (5) proper finishing and polishing of the restorations, and (6) proper planning for the continuing maintenance of these restorations. (13)

Guidelines for selection of material

A range of ceramic materials is presently available in the market with very different characteristics in terms of the composition, optic properties and manufacturing processes involved. Porcelain veneers have traditionally been made from aluminous or reinforced feldspathic porcelains that have relatively less strength, when compared to the pressed ceramics. Although pressed ceramics have gained lot of popularity there are clinical conditions where feldspathic ceramic restorations are preferred over pressed ceramic restorations. (14)

As a result, selection of the material best suited for the management of each individual patient may prove complicated.

For correct ceramic choice, Fons Font et al (15) recommended that the patients can be divided in terms of whether they are to be subjected to functional loading or not as:

(a) Type I patients
(b) Type II patients

Type I patients-

The facets in these patients are not exposed to functional loading, and are referred to as simple esthetic facets. Hence they are candidates for conventional ceramics.

These patients can be further sub grouped as:
1. Type I-A patients: Here the substrate teeth present no color alterations. Hence the only objective is to apply PLVs for shape modifying purposes.
2. Type I-B patients: Here the substrate teeth present color alterations. Hence the selected ceramic material must be able to hide the underlying substrate color.

Type II patients-

The facets in these patients are exposed to functional loading, and are referred to as functional esthetic facets. Hence these patients require high resistance ceramics.
Type I-A patients

The material used only aims to solve problems relating to tooth shape and also only a small ceramic material thickness is required. Hence these cases are considered as favorable. In such cases conventional feldspathic ceramics are recommended for use, in view of their excellent optic characteristics that afford optimum esthetic results.

But in cases of medium or large inter-incisal diastema cases (over 2mm) the porcelain extends beyond the adhesion zone, hence it loses the “protective” increase in elastic modulus afforded by the adhesion and composite resin. In such cases use of high resistance feldspate ceramics is recommended – since their good esthetic qualities combine with adequate resistance to fracture.

Type I-B patients

In these situations both the porcelain and cement must present various degrees of opacity in order to hide the color alterations, and this in turn implies problems to secure the desired optic effects in terms of translucency and reflectance, and consequently also the esthetic outcome.

Type II patients

In these cases the existence of functional loading in both the mandibular static position and during excursive movements requires the use of a material with great resistance to fracture. Accordingly, feldspate or alumina ceramics of high resistance, and oxide ceramics are indicated.

The use of high resistance ceramics with the lost-wax casting technique is also recommended because of its esthetic properties and predictability, in long term studies, in the oral rehabilitation of the anterior guidance.

Material Options

Feldspathic Porcelain:

Aluminosilicate ceramics found in nature which contain various amounts of potassium and sodium are known as feldspars. These ceramics contain a variety of oxide components including \( \text{SiO}_2 \) (52%-62%), \( \text{Al}_2\text{O}_3 \) (11-16%), \( \text{K}_2\text{O} \) (9-11%), \( \text{Na}_2\text{O} \) (5-7%) and certain additives.

When feldspar is heated at temperature between 1150°C and 1530°C it undergoes incongruent melting to form crystals of leucite in a liquid glass.(16)

Advantages of feldspathic ceramic:

- Less tooth structure removal (0.3 mm to 0.5 mm vs 0.6 mm to 0.8 mm)(17)
- More 3D appearance in thinner areas
- Ability to use same ceramic as in adjacent PFM's
- Ability to place different opacity levels within the restoration (17)

According to John Haupt2005, (18) layered feldspathic veneers are preferred when,

- Restoring tetracycline-banded discolored preparations, because layered porcelain powders provide more flexibility with respect to choice of opacity and translucent areas
- Doing conservative cases (e.g., younger people with large pulps), because less tooth structure needs to be removed.
- Diastema closures when shade is not altered significantly
- When minimal preparation is desired due to patient concerns or minimal changes in size, shape, and shade.

Feldspathic porcelains are built up using the platinum foil technique and hence provide greater latitude in building up colours and opacities. In recent times there has been a shift away from feldspathic porcelains, which is primarily due to reluctance on the part of technicians to fabricate feldspathic veneers, as they are more time consuming than pressed ceramic veneers.

Pressable ceramics

These basically belong to a category of glass ceramics, where filler particles are added to improve mechanical properties and to control optical properties. They are available from manufacturers as prefabricated ingots made of crystalline particles distributed throughout glassy materials. They can be further categorized as:

a. High Leucite containing glass (approximately 50%). Here Leucite crystals are added to the glassy phase
of an aluminosilicate glass. Ex. IPS Empress, Optec HSP, Finesse
b. Lithium disilicate glass ceramic. Aluminosilicate glass has around 70% lithium oxide added to it. Ex. IPS Empress II and IPS e Max (19)

Advantages of pressed ceramic:
- Wear compatibility
- Increased translucency
- Ability to wax-up final contours prior to pressing
- Stronger than feldspathic porcelains

According to John Haupt 2005, (18) pressed ceramics should be chosen when,
- When significant increase in tooth length is desired and when significant malposition exists in arch.
- Closing diastemas greater than 2–3 mm.
- Restoring severe wear cases or full-mouth reconstruction cases, due to the fact that pressed ceramics are inherently stronger and more durable.
- Combining veneers with full coverage restorations.
- When strength is of utmost importance.

Methods of fabrication of veneers
Four diverse laboratory techniques for fabrication of porcelain veneers have gained wide acceptance:
1. The refractory investment technique
2. The platinum foil technique
3. Castable and pressed porcelain veneers
4. Milling systems- CAD/CAM and copy milling

There are essentially two different methods available when fabricating multi-layered powder-liquid feldspathic all-porcelain restorations: the “old dog” platinum foiled system and the more contemporary refractory die system.

The Refractory Investment Technique
A master cast is poured using a hard die stone. Die spacer clearing the margins of preparations is applied on the labial surfaces of the teeth. For fabrication of refractory model, the undercuts on master cast are blocked with the help of block out wax. Now the cast is coated with silicone based lubricant and an elastic impression is made of the cast. A refractory investment material with co-efficient of thermal expansion similar to that of ceramic being used is poured into the impression. A sealant is applied on the dies and these dies are fired according to the firing cycle of porcelain being used.

After the veneers are fabricated, the refractory investment material is trimmed with an appropriate bur. Later the veneers are cleaned in an ultrasonic bath (20).

Hunt in 1990 suggested that veneers made on refractory dies are less susceptible to warping, and that thermal contraction may be controlled by reducing the size of the refractory die.

The Platinum Foil Technique
The foil that is usually used for veneering is 0.001 to 0.00085 inch in thickness. This foil not only acts as a surface substrate for veneer buildup but also serves to radiate heat during firing, bringing the entire porcelain to a uniform maturity. Individual dies are prepared for all the teeth to be veneered using hard die stone. All undercuts are trimmed from the dies.

The foil is cut into designated shape and systematically wrapped over incisal edge and into gingival or proximal margins. An orangewood stick is used to adapt and burnish the foil into an intimately fitting form. An alternative process involves “swaging” the platinum foil. In this procedure, the foil is adapted and lightly burnished to the die and wrapped with a protective plastic wrap. This is positioned in a swaging apparatus. Once the die is taken from swaging apparatus, the plastic wrap is removed, leaving behind a foil closely adapted to the die. This foil is carefully lifted from the die without distorting and held over Bunsen burner flame until it glows bright orange, to decontaminate and anneal it. This is later re-adapted and secured to the die with the help of sticky wax. Veneer build up is carried out. Once the veneers are ready, the foil is pulled away from the veneers with the help of a serrated tip tweezers.

Disadvantage of this technique is that, the margins of the dies easily get damaged during swaging or adaptation of the platinum foil. Chances of over contoured veneer fabrication are higher as the foil masks the margins on the cast. (21) These conventional methods result in a large amount of residual porosity. The crystalline particles that strengthen the material on a microscopic scale are not connected to each other, but are separated by glassy regions. The porosity and discontinuous nature of the crystalline phase lead to relatively low strength and a wide variation in strength. Ceramics fabricated by powder
condensation have greater translucency than can be achieved using other methods.(22)

Presssed ceramics

Presssed ceramics were developed to take advantage of the lost wax technique. They are fabricated by waxing up a tooth to the desired contour, investing it, and melting out the wax. A glass-ceramic ingot of the desired shade is plasticized at 920°C, at which they become a highly viscous liquid, and pressed into an investment mold under vacuum and pressure. Pressure is used for providing additional material as the porcelain cools and shrinks. This process is very similar to fabricating gold, and results in a porcelain ingot that fills out the desired contour in a single color. Ceramicists can then create more natural, less uniform coloration by cutting back the ingot and painting in different colored porcelains in different areas of the tooth. This results in a very dense ceramic material that fits like gold and has high flexural and compressive strength. (23,24)

Because the outside surface of the porcelain cools before the inside, it develops a lower coefficient of thermal expansion, causing it to expand more. The resulting compressive forces cause a further strengthening of the porcelain. Higher leucite content also contributes to increased strength of today’s pressed ceramics.

Tooth Preparation Guidelines For Porcelain Veneers

Preparations are always dictated 3-dimensionally by how the final restoration is placed within the frame of the face, lips, and gingiva. This is determined by smile design with patient input and needs to be verified functionally. The clinician should work backward and remove tooth structure based on the specific material requirements for space (i.e. thickness of the restorative material). Many of the techniques for margin design and volume of tooth structure removal are dictated by manufacturers’ requirements for a specific material. Although this is acceptable, if the clinical situation dictates it, many times this is not the case. Frequently, excessive tooth structure is removed so that a specific material or technique can be used, although another technique or material would have been the more conservative option. The material or technique should not be made to fit the clinical situation but rather the best material or technique should be chosen for the existing clinical situation.(25)

In the case of a translucent material such as a porcelain veneer, the desired color or shade change needs to be considered. Generally speaking, a veneer requires a minimum of 0.2 mm to (ideally) 0.3 mm of thickness for each shade change. For example, to go from an A3 to A0 requires 3 shade group changes and would need a minimum of a 0.6-mm to (ideally) 0.9-mm-thick veneer.(25)

Tooth preparation

Goals of the preparation include 0.5mm reduction on the incisal half of the facial surface, 0.3mm reduction on the gingival half, and chamfer finish line placed either at the crest of the gingiva or slightly subgingivally.(7) (Fig 1) First, the tooth is prepared faciaily. The required 0.5mm and 0.3mm reductions may be accomplished by placing depth orientation grooves using 0.3 and 0.5mm three-wheel diamond depth cutters.(7,26) The enamel between the depth cuts is removed with a round end tapered diamond until an even smooth surface is achieved. Once facial reduction is achieved, the preparation is carried around to the proximal. This may be performed with a round-end tapered diamond. The proximal reduction extends into the contact area but does not break contact.(7)(Fig 2,3&4)

Next, the incisal reduction takes place. Here, a decision must be made. The incisal finish line may be placed either at the incisal edge or slightly lingual to it (Fig 1),(7,26) If the second option is chosen, the tooth needs to be reduced 1-2mm in the incisal. The porcelain in that area will be subject to compressive forces during function, and porcelain is quite strong in compression. Faciolingual thickness of the tooth, the need for lengthening, and the patient’s occlusion help determine which approach to use. For example, a very thin tooth may result in exposed dentin if the finish line is placed on the lingual surface. That being said, there is some debate about whether or not to reduce the incisal. One source states that for most patients, coverage of the incisal edge is preferred. Other sources indicate that coverage of the incisal edge is unnecessary.(27)

According to A. W. G. Walls et al. (28) decision about incisal edge reduction should be made during treatment planning. There are four basic preparation designs that have been described for the incisal edge

1. **Window**, in which the veneer is taken close to but not up to the incisal edge. This has the advantage of retaining natural enamel over the incisal edge, but has the disadvantage that the incisal edge enamel is weakened by the preparation. Also, the margins of the veneer would become vulnerable if there is incisal edge wear whilst the incisal lute can be difficult to hide.(Fig1)

2. **Feather**, in which the veneer is taken up to the height of the incisal edge of the tooth but the edge, is not reduced. This has the advantage that once again guidance on natural tooth is maintained but the veneer is liable to be fragile at the incisal edge and may be subject to peel/shear forces during protrusive guidance.(Fig 1,2,3&4)

3. **Bevel**, in which a bucco-palatal bevel is prepared across the full width of the preparation and there is some reduction of the incisal length of the tooth. This gives more control over the incisal aesthetics and a positive seat during try in and luting of the veneer. The margin is not in a position that will be subjected to direct shear forces except in protrusion. However, this style of preparation does involve more extensive reduction of tooth tissue.(Fig5,6)

4. **Incisal overlap**, in which the incisal edge is reduced and then the veneer preparation extended onto
Porcelain Laminate Veneers: Making the right choices

the palatal aspect of the preparation. This also helps to provide a positive seat for luting whilst involving more extensive tooth preparation. This style of preparation will also modify the path of insertion of the veneer which will have to be seated from the buccal/incisal direction rather than the buccal alone. Care needs to be taken to ensure that any proximal wrap around of the preparation towards the gingival margin does not produce an undercut to the desired path of insertion for the veneer. It may be necessary to rotate such veneers into place by locating the incisal edge first then rotating the cervical margin into position. (Fig 1, 7, 8)

Castelnuevo et al. [29] found that 2 mm of free standing porcelain produced the strongest veneer and furthermore that a lingual chamfer actually reduced strength compared to a lingual butt joint. This seems to suggest that we need to prepare for 2 mm of porcelain and a lingual butt joint. (Fig 5, 6) The facial-incisal angle needs to be rounded off after you prepare the facial reduction. If the tooth is worn, you will need to reduce the incisal less that 2 mm since you will be planning for 2 mm of porcelain. The facial-incisal preparation allows for various paths of insertion and for extending into the gingival interproximal areas.

Magne and Douglas [30] stated that “each subsequent reduction in tooth structure resulted in a substantial increase in crown flexibility, even after restoration” and “veneered incisors should be considered to be similar to natural teeth and restored accordingly.” The more tooth reduction, the more the restored tooth will flex. We definitely don’t want the tooth to flex since that potentially results in cracked porcelain. They show that even a small fraction of remaining enamel will substantially stiffen the restoration compared to total enamel removal. With roughly 1 mm of facial enamel available on a typical incisor that means a typical prep for pressed ceramic would remove all the enamel. By contrast, about half the enamel needs to be removed for a feldspathic veneer. So it makes a lot of sense to conserve some enamel for reasons of strength, never mind the other obvious advantages of being in enamel.

Regardless of where the finish line ends up, it is placed with a round-end tapered diamond and should extend one quarter of the way down the lingual surface. [7] Care must be taken in this area. One of the common mistakes practitioners make is under-preparation of the tooth in the middle incisal third. [26] Other common mistakes include overall under- and over-preparation. Under-preparation results in a veneer that is either to thin and prone to fracture or one that is over bulked, which adversely affects the emergence profile and may be damaging to the gingiva. If the teeth are severely discolored to begin with, under-preparation may result in poor esthetic outcome. [26] Teeth that are over-prepared have lost enamel unnecessarily. Because so little tooth preparation is required for this procedure, it is important to be very exacting.

Enamel reduction is required to improve the bond strength of the resin composite to the tooth surface. [31]

Doing so, the apismatic top surface of mature unprepared enamel, which is known to offer only a minor retention capacity, is removed. In addition, care must be taken to maintain the preparation completely in enamel to realise an optimal bond with the porcelain veneer. [32] Christensen [33] states that 0.75 mm is the optimum amount of enamel that should be removed. According to Ferrari et al. [34], however, the extent and thickness of enamel in the gingival area of anterior teeth does not permit a reduction of 0.5 mm without encroaching upon the dentine. In addition, Natress et al. [35] found that in case of freehand preparation, the proximal and cervical enamel was reduced more than 0.5 mm in the vast majority of cases with exposure of dentine in most teeth.

The dentin-enamel junction (DEJ) is very important for the structural strength of the tooth. The explanation lies in the most fascinating feature inherent to the natural tooth—a complex fusion at the DEJ, which can be regarded as a fiber-reinforced bond. [36]

Because when we limit our preparations on enamel, the tooth will not flex and it will stay as rigid as a tooth can be. [37] Even if our preparation line passes through the DEJ margin and enters into dentin, it would not create a major problem for minor invasions. However, if we end up finishing our preparation on large amounts of dentin, we very well may end up with other kind of problems. This will not only create complex bonding issues on dentin, but will also free the “flexing” factor on the tooth structure. [38]

Over preparing the rotated or aggressive preparation of protrusively placed teeth will cause us to end up in the dentin structure which will lower our bonding values as well as causing the flexing of the tooth structure. And when the tooth starts flexing, a different phenomena occurs in this situation. First of all, we have the tooth which is aggressively prepared that wants to bend, to flex and on top of it we are bonding a veneer, a porcelain material, which is very rigid and in between those two structures we will be using the adhesive luting resin which will stay in between and will try to absorb all the stresses. If the tooth receives some different occlusal forces and keeps on flexing, the luting resin at the margin will start peeling off slowly. So in these situations we will most probably end up with some microleakage or de-lamination. [38]

If the porcelain cannot be supported by enamel, it is critical to design the preparation so the cemented veneer is subjected to minimal or no tensile or shear stresses. Laminated structures such as porcelain/enamel or porcelain/dentin by definition are a constant strain system. When a stress is applied in such a system, the material with the highest modulus of elasticity (stiffest) absorbs most of the stress. Because dentin is a lower modulus material (more flexible) than porcelain, it flexes more than enamel under a given load, thus subjecting the veneered porcelain to higher tensile and shear stresses. Being brittle, ceramics fail at a critical strain of 0.1%; therefore, bonding to the more flexible dentin could lead to early failure. The stiffness of enamel and its ability to
absorb stress clearly demonstrates the need to save as much enamel as possible and to ideally bond porcelain to enamel rather than dentin.(39)

Recent trends in tooth preparations for veneers are more aggressive than initially described 20 years ago. (Fig 9) Enamel is often minimal or absent so the veneers are adhered to primarily a dentin substrate. This trend may negatively impact the high level of success originally reported for these restorations. It may be due in part to the popularity of pressed ceramic veneers and the greater thickness demands of the fabrication technique. Some cohesive failures are inevitable simply because feldspathic ceramics cannot withstand high tensile stress. The clinician must be aware that proper case selection, material selection and tooth preparation—including an intraenamel preparation as much as possible—are important requirements for predictable success even when the latest dentin bonding agents are used. Factors such as unfavorable occlusion and extensive dentin exposure during preparation increase the chances of veneer failure.

Although the results of the newest generation dentin adhesive systems are very promising, the bond strength of porcelain bonded to enamel is still superior when compared with the bond strength of porcelain bonded to dentin (40,41). The vast majority of teeth receiving porcelain laminate veneers should have some enamel removal, usually approximately 0.5 mm, which allows for the minimal thickness of porcelain.

**Depth gauge vs silicone index**

There is a tendency for practitioners to under prepare teeth for porcelain laminate veneers with under preparation of the middle incisal third of the tooth being especially common.(42,43) Given the tendency to under preparation when teeth are prepared freehand, it is recommended that either an index or appropriate depth gauge bur are used when teeth are prepared for porcelain laminate veneers. Some freehand preparation of severely discoloured teeth will still be required so as to ensure a successful aesthetic outcome, an increased thickness of porcelain and/or luting cement in the final restoration having a greater masking ability. (44) Similarly teeth, which have suffered some degree of noncarious tooth surface loss should be prepared accordingly with a combination of margin definition and selected free hand reduction where appropriate. Blanket preparation with an index or depth gauge bur would not be appropriate in such cases. (45)

The present trend when teeth are prepared for porcelain laminate veneers is to include the incisal edge either by bevelling or by means of overlapping. A silicone index is more helpful than a depth gauge bur when preparing the palatal surface and reducing the incisal edge, a depth gauge bur having limited application in these situations. It could be considered that a disadvantage of making an index of addition-cured silicone is the expense in terms of material and time required to produce such an index. It is suggested however that the benefits to the patient and the operator from using a silicone index far exceed the additional cost of fabricating the index. A further advantage of a silicone index is that it can be sectioned so that the parts can be relocated accurately. The index can then be reconstructed and used to fabricate a temporary restoration. If a depth gauge bur is used in preference to a silicone index minimal smoothing of the labial face to prevent over preparation is recommended.(44)

**Conclusion**

Porcelain veneers are a fantastic option for patients who are searching for esthetic anterior restorations. They are conservative, require minimal loss of tooth structure, and hold up well over time. By using porcelain veneers, the dentist can help a patient who is dissatisfied with dark, malformed or fractured teeth. The dentist must also determine if contraindications exist, and if so, guide the patient in other directions. Other options to be considered are composite veneers, a less expensive, less time-consuming but less stable approach, and bleaching.

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Surface microhardness and scanning electron micrograph of white mineral trioxide aggregate in the presence of acidic pH

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Abstract

Aim: The aim of his study was to evaluate the surfacemicrohardness and morphologic microstructure of white mineral trioxide aggregate (WMTA) following exposure to a range of acidic environments during hydration.

Methodology: WMTA was mixed and packed into 33 cylindrical polycarbonate tubes. Three groups, each containing 8 specimens, were exposed to pH values of 5.4, 6.4 and 7.4, respectively, for 4 days. Vickersmicrohardness of the surface of each specimen was measured after exposure to acidic environments. Data were subjected to one-way anova and Tukey HSD test. Three groups, each of three specimens were prepared and treated in the same way prior to qualitative examination by scanning electron microscope(SEM).

Result: The greatest mean surface hardness values (54.91 ± 1.81) were observed following exposure to pH 7.4 with the values decreasing to 38.46 ± 2.20 following exposure to pH 5.4. The difference between these values was statistically significant (P < 0.001). There were no distinct morphological differences between groups in terms of the internal microstructure. However, a trend was observed that the more acidic the solution, the more extensive the porosity of the specimens.

Conclusion: Under the conditions of this study, surface hardness of MTA was impaired in an acidic environment.

Keywords: acidic, microstructure, mineral trioxide aggregate, scanning electron microscopy, vickersmicrohardness.

Introduction

Mineral trioxide aggregate (MTA) was developed and introduced for use in endodontics for the repair of root perforations at Loma Linda university in the 1990’st(1). It was then widely used as a root-end filling material and for vital pulp therapy, including direct pulp capping and pulpotomy of immature teeth with vital pulps (apexogenesis). In addition, because of its sealing ability, it was also suggested as an apical barrier in treatment of teeth with open apices and necrotic pulps (apexification)(2).

Two commercial forms of MTA are available. ProRootMTA (Dentsply), is available as grey and white MTA, both with similar chemical and physical properties. MTA-Angelus has also become available in the market(1). The more esthetic white–colored preparation lacks the tetra calcium alumino ferrite. The lack of this iron - containing compound may account for its white appearance(3).

The use of MTA as a root end filling material was identified because the material is a hydraulic cement that sets in the presence of water(1). Camilleri et al has shown using x-ray diffraction analysis that MTA is composed primarily of tricalcium silicate, dicalcium silicate and bismuth oxide, which on hydration produce a silicate hydrate gel and calcium hydroxide, thus rendering the material biocompatible(4).

In some clinical situations MTA may be directly exposed to an acidic environment which can affect the physical and chemical properties of MTA placed in that area. MTA has a pH of 10.2 initially and which can increase to 12.5 within three hours after mixing. However, it is possible that variations in the pH of the host tissues can occur due to the presence of pre-existing pathological conditions, like open apex, non vital teeth with periapical lesions, lateral or furcal perforations with radiolucent lesions(2).

The present study was designed to evaluate the surfacemicrohardness of WMTA following exposure to a range of acidic environments during hydration. The morphological and microstructural features of the samples were studied using SEM.

Materials and methods

The parameters investigated were surface hardness (Vickers microhardness), and assessment of morphological characteristics using SEM. The material investigated was the WMTA (Angelus, Brazil).

Methodology:

Preparation of the Mould:

Thirty three cylindrical moulds of size 6 mm diameter and 10 mm length were fabricated using sections of sterilized poly vinyl chloride pipe as mould. All the moulds...
were cold sterilized using 2% Glutaraldehyde for 6 hrs, after which they were cleansed with sterile water and allowed to dry in open air.

Manipulation of MTA:

WMTA was mixed separately on a glass slab with a cement spatula in a water powder ratio as recommended by the manufacturer. The mixed cement was carried with amalgam carrier and was condensed upto 5 mm inside the prepared moulds using the amalgam condenser. Three groups each of eleven specimens were prepared. The material was compacted evenly into the cylindrical mould using a custom-made device containing a stainless steel piston with the similar internal diameter of polyvinyl cylindrical tubes under a pressure of 3.22Mpa which was applied for 1 min to standardise the compaction of material. A wet cotton pellet was placed on the samples within the polyvinyl tube to simulate the clinical scenario and stored at room temperature within a glass vial for 4 days. The bottom of each vial contained a piece of 2 cm X 2 cm gauze that had been soaked in distilled water. Based on pilot experimentation, the acid-soaked pieces of gauze were replaced with fresh acid-soaked gauze every 24 h to ensure a consistent pH during the experimental period. The openings of the glass vials were then covered by moist gauze and covered to ensure the presence of sufficient humidity inside the vials. After 4 days, the MTA specimens were removed from the moulds.

Microhardness testing

The surfaces exposed to acid on each specimen were then wet polished at room temperature using minimum hand pressure and silicon carbide-based sandpapers of varying particle size of 600-grit and 1200-grit. The polished specimens were cleaned gently under light pressure distilled water to remove surface debris. To prevent dissolution or water sorption, the surfaces were dried gently by air spray. The Vickers microhardness test of each specimen was performed with a square-based pyramid indenter at a full load of 50 g for 5 s at room temperature. Five indentations were made on the polished surface of each specimen at separated locations no closer than 1 mm to adjacent indentations or the specimen periphery. The diagonal of the resulting indentation was measured immediately under the microscope and the Vickers microhardness value displayed on the digital readout of the microhardness tester. The Vickers microhardness (HV) was calculated based on the following formula approximately where \( F \) is load/kg; and \( d \) is the mean of the two diagonals of the impression made by the indenter in millimetres. The mean value of the hardness value obtained was calculated to determine the hardness value for each specimen.

Scanning electron microscopy:

For the microstructural morphological evaluations by SEM, nine specimens (three for each group) were prepared using the same pressure to condense the material and then stored for 4 days under the same conditions whilst exposed to either pH 5.4, 6.4 and 7.4, respectively. The specimens were sectioned into two halves using a disposable surgical scalpel blade No. 15 to initiate the crack and were further split into two halves using a cutter. The surfaces were sputter-coated with gold using a Polaron Sputter Coater and specimens were analysed with Scanning Electron Microscope. The micrograph images from the SEM analysis showing the qualitative internal micro structure of the set MTA were evaluated at the same depth within the specimens in terms of the presence of micro channels and type of crystal formation.

Results:

Microhardness:

The microhardness testing experiment results of WMTA at various pH are presented in Table 1. The highest mean surface hardness values were observed following exposure to a pH 7.4. The values decreased following exposure to pH 6.4 and the lowest mean surface hardness values were observed following exposure to pH 5.4. The results of the present study were subjected to statistical analysis to interpret the significant differences between the various pH in the groups. One-Way ANOVA followed by post hoc Tukey’s test was used for statistical analysis in the present study. It was found that the difference between the values of WMTA specimens exposed to different pH (5.4, 6.4, 7.4) were statistically significant.(\( P < 0.001 \))

<table>
<thead>
<tr>
<th>pH</th>
<th>MICROHARDNESS</th>
<th>MEAN</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>5.4</td>
<td>38.46a</td>
<td>2.20</td>
<td></td>
</tr>
<tr>
<td>6.4</td>
<td>47.20b</td>
<td>1.56</td>
<td></td>
</tr>
<tr>
<td>7.4</td>
<td>54.91c</td>
<td>1.81</td>
<td></td>
</tr>
<tr>
<td>P VALUE</td>
<td>&lt; 0.001**</td>
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</tbody>
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Note ** denotes significant at 1% level.
Different alphabets between subgroups denote significance at 5% level.

Scanning electron microscopy:

The internal microstructure of all the specimens that were exposed to various pH revealed a variety of structures. Specimens exposed to butyric acid with pH 7.4 showed bundles of jagged needle like formations and had distinctive crystalline structure embedded within a more uniform and homogenous matrix that was partially covered by a gel form structure (Fig 1). As the pH decreased to 6.4 structures such as microchannels, porosities and assymetrical crystalline formations in the form of...
laminated cross stratified structures were seen (Fig 2). The porosity increased and the pore size diameter was larger when compared to that of pH 7.4. Specimens exposed to more acidic pHs, 5.4 revealed porosities, depressions caused by air bubbles and also a few microchannels (Fig 3). The porosity was extensive on the surface of MTA. The pore size diameter was still larger when compared to pH 6.4 and 7.4.

**Discussion:**

Within the human body under normal physiologic conditions, any minor change in pH is controlled by the carbonic acid-bicarbonate buffer system and the other pH regulatory systems active in connective tissue; periodontal tissue is no exception. However, in certain clinical applications, MTA is placed in an environment where inflammation is present and the surface of the unset material will be exposed to a low pH environment (acidic pH). In addition, in some clinical situations like open apex, nonvital teeth with periapical lesions, lateral or furcal perforations with radiolucent lesions, MTA might be directly exposed to an acidic environment(2).

The pH of the human abscess has been measured as low as 5.0. This low pH could potentially inhibit not only the setting reaction, but also affect adhesion and increase the solubility of dental materials(5). Physical and chemical properties of MTA also might be influenced in a low pH environment. Impeded MTA setting as well as reduced strength and hardness has been reported in an acidic environment(6). Thus it is possible that variations in the pH value of the host tissues, because of pre-existing pathologic conditions at the time of MTA placement, might affect its hardness and jeopardize the outcome of the treatment(2,6). Hence, in the present study, the influence of pH on the surface hardness and microstructure of WMATa has been investigated and compared. Poly Vinyl chloride moulds were used to compact the WMATa as these moulds do not interfere with the chemical constituents of the material. The moulds were of size 10mm length and 6mm in diameter, as 3-5mm of MTA is the ideal thickness needed to prevent microleakage. Mixing was done according to manufacturer’s instructions and the material was compacted evenly into the cylindrical mould using a custom-made device containing a stainless steel piston with 5mm internal diameter of polyvinyl cylindrical tubes. Based on the inference of the study by Nekoofar et al, the condensation pressure of 3.22Mpa was applied for 1 min. The samples were thus subjected to a constant vertical force that was translated into a transverse and equally distributed pressure that compacted the MTA evenly into the cylindrical mould(7). MTA is a type of hydraulic cement that can set in the presence of water(8). Matt et al, Sarkar et al, showed that additional moisture from a cotton pellet is crucial for the material to establish its optimum properties. Hence, a wet cotton pellet was placed over the samples within the polyvinyl tube to provide relative humidity for setting reaction of the material(9,10). It is recommended that MTA be allowed to set untouched for 72 hours or longer to decrease the chance of MTA displacement(11,12,13). Vander Weele et al showed that significantly greater forces was required to displace all samples at 7 days than was required at 24 hours and 72 hours. This suggests that after initial 24 hours or 72 hours disturbance, MTA was still setting. It was concluded that allowing the MTA to set undisturbed for 7 days before placement of a coronal restoration may decrease the chances of MTA displacement(14). When inflamed tissues are removed during periapical surgery, the pH of tissues adjacent to root-end filling and its interface with dentin might be changed to neutral in less than 3 days. Furthermore, Lee et al demonstrated that, in situations where the initiating and perpetuating factors of an inflammatory process are removed by appropriate treatment, it is possible that the pH of the environment returns to normal in a shorter time period than the 7 days. Therefore in this study, MTA was exposed for no longer than 4 days to the acidic solution in order to simulate the situation in which the initiating and perpetuating factors of inflammatory processes are removed by appropriate treatment(15). Lee et al studied the effect of pH on the hydration process of MTA. They immersed and stored MTA samples in solutions of pH 5, 7 and 7.4 for 7 days and reported that their microhardness at low pH was reduced. However, immersion of the material in acid does not
simulate clinical conditions, as most often only a part of the surface of the MTA will be exposed to an acidic environment. Hence in the present study, attempts were made to mimic the clinical situation by exposing MTA to acid-soaked pieces of gauze placed at the bottom of each vial(16).

Various types of acid have dissimilar effects on the physical and chemical characteristics of MTA. In the present study butyric acid, a by-product of anaerobic bacterial metabolism was used to simulate the clinical conditions of periradicular infections. To ensure a consistent pH during the experimental period, the acid-soaked pieces of gauze were replaced with fresh acid-soaked gauze every 24 hours. The openings of the glass vials were then covered with moist gauze and covered to ensure the presence of sufficient humidity inside the vials. Similar procedures were observed in previous studies by Namazikhah et al, Nekooaf et al, & Saghir et al (2,7,17,18). MTA fails to set on few occasions, and this has been reported in a few studies. In those cases the MTA material required replacement at a further appointment. One reason for this lack of hydration during setting reaction may be attributed to the acidic pH of the inflamed tissue in contact with the material, including the presence of various acids secreted by bacteria in the infected site. The present study supports the results given by Lee et al that, MTA does not harden well as the pH decreases. Further, a few more studies revealed that, the physical and chemical properties of MTA might be influenced in a low pH environment(16). Strength and hardness may not be of paramount importance when MTA is used as a root-end filling, but any subsequent replacement of an associated orthograde root canal filling would require the root-end filling to have adequate strength as reported by Saghir et al. The applications for the use of MTA have broadened and sufficient strength must be considered important. The extended use poses additional demands on the development of MTA. The strength and hardness of the material must be viewed as a more critical property. Measurement of the Vickers microhardness formed the basis of the present investigation. An optical microscope (CLEMEX, CMT), with a magnification of X 500 was used to measure to an accuracy of +0.5 micrometres Danesh et al. reported that the Vickers microhardness of MTA was 39.99. Lee et al. noted that the microhardness of MTA using the Knoop scale was 51.20(2). The results of the present study were tabulated and subjected to statistical analysis to interpret the significant differences between the various pH in the WMTA group. Vickers microhardness of all the experimental samples were significantly affected by low pH environments. At pH 7.4, the surface microhardness of WMATA was 54.91, with the Vickers scale, this value decreased significantly following exposure to pH 6.4 whereas at pH 5.4 the microhardness values of WMATA was 38.46. This finding of the present study was in accordance with Lee et al who reported that weaker specimens resulted from immersion and storage in a low pH environment(16).

The microhardness and the microstructure of all the experimental samples in the present study were significantly affected by the low pH environment (i.e) the microhardness at pH 5.4 was least followed by pH 6.4 and 7.4. Thus it was observed that the results of Saghir et al’s study coincided with the results of this present study(18).

Watts et al studied the effects of pH and mixing agents on the temporal setting of tooth-colored and grayMTA. He tested the compressive strength, as a measure of relative set cement, of WMATA and GMTA when mixed with sterile water or local anaesthetic and exposed to an acidic environment. He concluded that an acidic pH caused a decrease in compressive strength (and thus possibly the quality of the set cement) in WMATA and GMTA when mixed with local anaesthetic solution. The present study, to simulate the acidic environment, buffered butyric acid was used at various pH levels. The results of the present study was also in accordance with the results of the study by Watts et al(5).

In the SEM analysis, the internal microstructure of the specimens exposed to pH 7.4 showed distinctive crystalline structure embedded within a more uniform matrix. Bundles of needle-like crystals were also appreciated. The surface changes in the present study when exposed to pH 7.4 was similar to the results of the study by Lee et al. They found that the microstructure of hydrated MTA consists of cubic and needle-like crystals. Similarly in his study, in those specimens immersed in pH 5, he observed only erosion of cubic crystal surfaces instead of needle like crystals. SEM micrographs of MTA stored in pH 5 clearly showed that the crystalline structure maturity paled in contrast to the formations of the other specimens. Hence, they concluded that, an acidic environment of pH 5 adversely affected both the physical properties and the hydration behaviour of MTA. In the present study, greater degree of porosity was seen in all the experimental samples that were exposed to the pH 5.4 and pH 6.4. No needle-like crystals were observed when exposed to low pH environments. This result of the present study was in accordance with the results of the study by Lee et al(16).

Conclusion:

Under the conditions of this study, surface hardness of MTA was impaired in an acidic environment. In terms of the internal microstructure, there were no distinct morphological differences between groups. However, a trend was observed that the more acidic the solution, the more extensive the porosity of the specimens.

References:


Inferior alveolar nerve (IAN) block is the most frequently used injection technique for achieving local anesthesia for mandibular restorative and surgical procedures. However, the IAN block does not always result in successful pulpal anesthesia (1). Failure rates of 10 to 39% have been reported in experimental studies (1). Clinical studies in endodontics have found failure with the IAN block occurring between 44% and 81% of the time. When these procedures involve vital pulp tissue, there is occasionally lack of pulpal anesthesia despite administration by a block, infiltration, or a supplemental technique, such as the periodontal ligament or the intraosseous injection. Profound anesthesia is required to access the chamber and extirpate the pulp. If patient discomfort is encountered, the intrapulpal injection may be used as a supplement for pulpal anesthesia.

For the intrapulpal (or any other) injection to be successful, there are a number of factors to be considered. Literature suggests different mechanisms by which the intrapulpal injections work. Some studies state that the anesthesia effect of the intrapulpal injection was due to the back-pressure of the solution and was not dependent on the type of solution they injected (2). Research has confirmed the presence of alpha L adrenergic receptors in the blood vessels of the pulp, these receptors are capable of responding to low doses of epinephrine causing vasoconstriction. Intrapulpal injections of epinephrine resulted in local pulpal ischemia with a subsequent decrease in the number of action potentials produced by pain-eliciting stimuli. They concluded that sensory receptors require normal local blood flow to remain sensitive.

Malamed (3) states that intrapulpal anesthesia is a result of the anesthetic solution in combination with applied pressure.

The purpose of this study was to determine whether the effectiveness of the intrapulpal injection was dependent on local anesthetic solution delivered with back pressure or solely back pressure only. (2)

**Materials and method**

Patients were recruited from outpatient clinic of Department of Conservative Dentistry & Endodontics and Department of Oral medicine, Vinayaka Mission’s Sankaracharyar Dental college, Salem.

After completion of dental and medical history, a clinical examination with an explorer and periodontal probe was performed. Vital mandibular posterior teeth with pulpsitis which needed root canal therapy were included in this study.

Inferior alveolar nerve block injection was administered using 1.8 ml of 2% lidocaine with 1:1,000 epinephrine with conventional long buccal injection. After injection of anesthetic agent, a waiting period of 15 minutes was observed prior to evaluating each patient for subjective signs of clinical anesthesia consisting of lower lip and tongue numbness. All of the patients in this study reported subjective symptoms within the 15 minutes waiting period.

If the normal teeth (control teeth) do not show response to the cold test or did not respond to the maximum output of the pulp tester at two or more consecutive time points, the teeth were isolated with a rubber dam and access performed. (4) The patients are instructed to rate any discomfort during access using a Heft-Parker visual analogue scale (VAS). The VAS scale is divided into four categories:

1) 0.0 mm - No pain
2) 0-54 mm - Mild pain (faint, weak, and mild)
3) 55-113 mm - Moderate pain
4) =/ > 114 mm - Severe pain (strong, intense and maximum possible)

Visual analogue scale. The millimeter demarcations will not be shown on the patients ‘VAS scale’

Patients are instructed to place a mark on the line to show the amount of pain that they feel. The patients, who had moderate or severe pain (VAS rating greater than 54 mm) on access into dentin, when entering the pulp chamber or with initial file placement, has been selected for a supplemental intrapulpal injection.

Patient consent was procured before giving the intrapulpal injection, to participate in the study. Patients were selected in a random manner to receive one or the other of the solutions (normal saline solution or 2% lidocaine with 1:100,000 epinephrine or plain lignocaine).

In the intrapulpal injection was given with backpressure by Post Graduates students of the department of Endodontics, Vinayaka Mission’s Sankaracharyar Dental college, Salem.

A standard anesthetic syringe was used with either a 27, or 30 gauge needle. Definitive back-pressure was...
required for a treatment case to be included in this study. Adequate back-pressure means a definite resistance on the syringe handle when a moderate force was used to inject the solution.

Results

Results showed the intrapulpal injection was quite successful with no difference between the solution used (normal saline solution or 2% lidocaine with 1:100,000 epinephrine or plain lignocaine).

Out of the seventy patients who were delivered intrapulpal injections, in seven cases adequate back pressure was not felt, so were not included in the study.

Intrapulpal injections given with back-pressure, sixty three were effective. Twenty three of the injections were given with 2% lidocaine with 1:100,000 epinephrine, twenty two were given with plain lignocaine, and eighteen were given with normal saline solution.

There was no significant difference between the evaluators in all the groups. Therefore, any difference in anesthetic efficacy would be due to procedural variable and not due to inter examiner disagreement. There was no statistically significant difference as to success/ nonsuccess between the solutions, demonstrating that success depends on back-pressure.

Discussion

The inferior alveolar nerve (IAN) block is the most frequently used injection technique for achieving local anesthesia for mandibular restorative and surgical procedures. However, the inferior alveolar nerve block does not always result in successful pulpal anesthesia (1). Failure rates of 10 to 39% have been reported in experimental studies (1). Clinical studies in endodontics have found failure with the inferior alveolar nerve block occurring between 44% and 81% of the time.

It has been suggested that inflammation and infection lower tissue pH altering the ability of the local anesthetic to provide clinically adequate pain control. It has also been suggested that the inflammation alters peripheral sensory nerve activity and can lead to inability of local anesthetic to prevent impulse transmission. Previous studies have cited several reasons for inferior alveolar nerve block failures in healthy or inflamed pulps. The reasons include pulpitis, anatomic differences (such as accessory innervations, bifid inferior alveolar nerve, anatomic position of the mandibular canal), concentration of anesthetic agent, volume of anesthetic solution, patient’s level of anxiety, and a patient’s past history with successful anesthesia, increased activity of the tetrodotoxin resistant (TTXr) class of sodium channels that may also be resistant to the action of local anesthetics, increased overall expression of sodium channels in pulps diagnosed with irreversible pulpitis, altered membrane excitability of peripheral nociceptors and central sensitization that amplifies peripheral input from afferent neurons. So supplemental injections are of due importance.

In this study, all intrapulpal injections given with back-pressure, were effective. Twenty three of the injections were given with 2% lidocaine with 1:100,000 epinephrine. Twenty two were given with plain lignocaine, and eighteen were given with normal saline solution.

As with any dental procedure, proper case selection is important for success. Out of the seventy patients who were delivered intrapulpal injections, in seven cases adequate back pressure was not felt. Those with out backpressure failed to produce adequate anesthesia.

The intrapulpal injection is not an appropriate supplement if, for any reason, back-pressure cannot be achieved or if the pulp tissue is inaccessible to the effects of the back-pressure such as the case with tissue located deep within a very narrow or curved canal, wide access cavities & large carious exposures.

The intrapulpal injection is an effective and useful injection when used properly and under appropriate circumstances. It is critical that the clinician be aware of proper case selection when considering the intrapulpal injection in order to take full advantage of its benefits.

The periodontal ligament injection is usually considered the preferred supplemental technique to obtain profound pulpal anesthesia if the standard block or infiltration injection is not effective. The intrapulpal injection is considered an additional option if the periodontal ligament injection does not effect profound pulpal anesthesia.

Conclusion

The results of our study indicate that the effectiveness of the intrapulpal injection is dependent on back-pressure and is independent of the solution used.

References

Comparative evaluation of smear layer removal by EDTA & MTAD - A SEM study

* Joseph Paul, ** Sateesh Kumar, *** Chokalingam **** Prasad ***** Kiran Kishore

Abstract

Aim: To evaluate smear layer removal by various irrigating solutions.

Methodology: Sixty extracted maxillary single-rooted human teeth were prepared by using a combination of passive step-back and rotary Nickel-titanium files. 5.25% sodium hypochlorite was used for recapitulation in between filing. They were further divided into two equal groups. According to the final rinse employed - 5 ml each of 17%EDTA and MTAD accordingly. The scanning electron microscope images of the longitudinal sections of the teeth were scored and analyzed.

Results: Smear layer removal was noted in all the groups. MTAD & EDTA showed smear layer removing capacity in the ascending order. No erosion of the dentinal tubules was noted with MTAD.

Introduction

Recent advances in the chemistry of dentin bonding systems have improved short-term bond strength, however the long-term clinical outcome of esthetic restorations bonded to dentin is still unclear. Research indicates that bond strength is related to resin penetration of intertubular dentin to form a "resin-dentin interdiffusion zone (1)". Dentin is a challenging substrate for bonding due to its heterogeneity. Any variation other than normal may interfere in bonding.

Pre-treatment of the dentin surface with acid conditioning agents result in the removal of the smear layer, smear plugs and result in superficial demineralization of the inorganic components of the intertubular and/or peritubular dentin, exposing a collagen-rich transition zone into which resins can diffuse (PASHLEY et al. 1994, TAY et al. 1995). It has been hypothesized that in fluorosis induced changes in structural and mineralization patterns of dentin may influence the smear layer removal (2).

Various materials and techniques have been reported with wide variations in their efficacy regarding removal of the intra canal smear layer. Scanning electron microscopy (SEM) can shed light on how the severity of dental fluorosis influences the mineralization pattern of dentin, the part of the tooth where the influence of this element is less well-known (3). In the present study we compare efficacy of EDTA and MTAD in removing smear layer.

Materials and methods

Sixty extracted maxillary single-rooted human were collected. After access opening, their working length were established. Chemomechanical preparation with NiTi files and was irrigated with NaOCl solution after each file. Following this, the two groups were further divided into three sub groups as follows:

- group I : MTAD used as final rinse
- group II : EDTA used as final rinse

Irrigation was done after each instrument with 5ml of the test solution using a syringe, the needle was placed as far as possible into the canal without binding. The root canals were finally irrigated with 3ml of distilled water to remove any precipitate that may have formed from the test irrigants. After the root canal preparation, the canals were dried with paper points. A cotton pellet was placed in the access cavity and the tooth was stored in a plastic bag placed in a humidor. A longitudinal groove was cut on the buccal and lingual surface without penetrating the canal using a fine diamond bur. Each tooth was then split into two with cutting pliers and stored until analysis with SEM.

The specimens were dehydrated and coated with gold using an ion sputter and immediately examined for SEM evaluation. Several photomicrographs were made at X2500 magnifications, at cervical, middle and apical third to observe the surface morphology. The representative areas were evaluated under the following criteria by two independent evaluators who did not know the groups to which the samples belonged. The scoring was made.

Score used (4)

0 No smear layer, all dentinal tubules open
1 Minimum smear layer; > 50% dentinal tubules visible
2 Moderate smear layer; < 50% of dentinal tubules open
3 Heavy smear layer; outline of dentinal tubules obliterated

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** Professor
*** Reader
**** Senior Lecturer
***** PG Student, Dept of Conservative Dentistry and Endodontics, VMSDC, Salem
The acquired data was then subjected to statistical analysis, using chi-square test to find out the association between the groups and the level of smear layer left. Since the p value is less than 0.01 there is highly significant association is found between the group and level of smear layer irrespective of the solution.

Results

Results showed there was significant association between the groups and levels of smear layer left. There was no significant difference between the two evaluators in all the groups. Therefore, any difference in smear layer removal efficacy would be due to procedural variable and not due to inter examiner disagreement.

Discussion

Research indicates that bond strength is related to resin penetration of intertubular dentin which is influenced by smear layer left (5). The adhesive ability of sealers was found to vary markedly according to the final rinse employed (6). The smear layer has been described as one that is formed during instrumentation, consisting of not only dentin but also necrotic and viable tissue, including remnants of odontoblastic processes, pulp tissue and bacteria. Pre-treatment of the dentin surface with acid conditioning agents results in the removal of the smear layer, smear plugs and the superficial demineralization of the inorganic components of the intertubular and/or peritubular dentin, exposing a collagen-rich transition zone into which resins can diffuse. The formation of smear layer appears to be influenced by the degree of demineralization which in turn is affected by the disease process or by the environmental factor like fluoride (8). In this study we used SEM images to compare the efficacy of smear layer removal in fluorosed and non fluorosed teeth using two different irrigating solution i.e., MTAD, EDTA.

Although sodium hypochlorite appears to be the most desirable single endodontic irrigant, it cannot dissolve inorganic dentin particles and thus prevent the formation of a smear layer during instrumentation. Demineralizing agents such as ethylenediamine tetraacetic acid (EDTA) and citric acid have therefore been recommended as adjuvants in root canal therapy. Although citric acid appears to be slightly more potent at similar concentration than EDTA, both agents show high efficiency in removing the smear layer (7). In addition to their cleaning ability, chelators may detach biofilms adhering to root canal walls. An alternating irrigating regimen of NaOCl and EDTA may be more efficient in reducing bacterial loads in root canal systems than NaOCl alone. Both citric acid and EDTA immediately reduce the available chlorine in solution, rendering the sodium hypochlorite irrigant ineffective on bacteria and necrotic tissue Hence, citric acid or EDTA should never be mixed with sodium hypochlorite.

MTAD. Bio PureMTAD (Dentsply, Tulsa, OK) is a mixture of a tetracycline isomer, an acetic acid, and Tween 80 detergent (MTAD)—was designed to be used as a final root canal rinse before obturation. Tetracycline has many unique properties of low pH and thus can act as a calcium chelator and cause enamel and root surface demineralization (8). Its surface demineralization of dentin is comparable to that seen using citric acid. In addition, it has been shown that it is a substantive medication (becomes absorbed and gradually released from tooth structures such as dentin and cementum)

<table>
<thead>
<tr>
<th>Group</th>
<th>Level of Smear layer</th>
<th>Total</th>
<th>F</th>
<th>%</th>
<th>Chi square</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Nil</td>
<td>Minimum</td>
<td>Moderate</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>N</td>
<td>%</td>
<td>N</td>
<td>%</td>
<td>N</td>
<td>%</td>
</tr>
<tr>
<td>EDTA</td>
<td>7</td>
<td>3.89</td>
<td>34</td>
<td>18.89</td>
<td>49</td>
<td>27.22</td>
</tr>
<tr>
<td>MTAD</td>
<td>43</td>
<td>23.89</td>
<td>47</td>
<td>26.11</td>
<td>90</td>
<td>50</td>
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<tr>
<td>Total</td>
<td>50</td>
<td>27.78</td>
<td>81</td>
<td>45.00</td>
<td>49</td>
<td>27.22</td>
</tr>
</tbody>
</table>

** Highly Significant (p < 0.01)
MTAD has some advantages over conventional irrigants and solutions used in root canal treatment. MTAD is effective in removing the smear layer along the whole length of the root canal and in removing organic and inorganic debris and not does produce any signs of erosion or physical changes in dentine, whereas a mixture of 5.25% sodium hypochlorite and 17% EDTA does.

Conclusions
1. Smear layer removal was noted in all the groups. MTAD & EDTA showed smear layer removing capacity in the ascending order.
2. No erosion of the dentinal tubules was noted with MTAD.
3. The difference in smear layer removal between both the groups may influence resin penetration and bond strength.

References
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Study of pulp space anatomy using Multi Slice Computed Tomography (MSCT) – An in vitro study

* Aditya Shetty, ** Mithra N. Hegde, *** Uday S. Mahale, **** Pooja Shetty, ****** Vijay S. Bhat, ****** Amit Malhotra

Abstract

Of all the phases of anatomic study in the human system, one of the most complex is that of pulp cavity morphology. The success of endodontic treatment depends on the identification of teeth requiring treatment and then the recognition of the root canal system, so it can be cleaned, shaped and obturated. Multi Slice Computed Tomography has revolutionized x-ray imaging by providing high quality images, which reproduced transverse cross sections of the body. Traditional 2-D imaging is an acceptable first choice in the diagnosis and treatment of dental pathology. However, cone beam imaging is now becoming a complementary technology. Major limitation of 2D imaging is that, we can perceive the apparent anatomy. Actual endodontic anatomy can be studied by 3D imaging modality. Advantages of MSCT:-

- Incorporating quality new information not available by other modalities
- Highest resolution possible
- Multiple fields of view (FOV)

Present limitations of MSCT:-

- limit contrast resolution
- scattered radiation to cause increased noise
- heel effect
- detector imperfections affecting linearity in response to x-radiation

Considering the advantages and limitations of MSCT, to get the clear idea of quality of image and feasibility of procedure, we carried out a study by taking MSCT images of extracted teeth with following variables:-

1. Introduction of radio-opaque dye into pulp space
2. Peg shaped lateral tooth as an altered morphology

CBCT could give the diagnostically valuable high quality images.

Keywords:- CBCT, Endodontic Anatomy, Dental Imaging

Introduction:-

Of all the phases of anatomic study in the human system, one of the most complex is that of pulp cavity morphology. Anatomical variability of the teeth is often a complicating factor in root canal treatment and many different methods have been used to investigate the root canal morphology.

The success of endodontic treatment depends on the identification of teeth requiring treatment and then the recognition of the root canal system, so it can be cleaned, shaped and obturated. However, in order to achieve this, it is imperative that the operator should have detailed knowledge of the root canal anatomy of the tooth being treated.

As a cause of treatment failures, the lack of working knowledge of pulpal anatomy ranks second to the errors in accurate diagnosis and treatment planning.

Many in vitro approaches has been used till date to study the internal anatomy of root canal viz. cross sections of human root canal at various levels to directly view the shape and position of the root canal[1], radiographic imaging [2] and longitudinal cleavage of teeth [3]. Recently, practical and nondestructive technique for assessment of root canal morphology has been advocated i.e. MSCT, which provides cross sectional and 3D images that are highly accurate and quantifiable.[4,5]

The most common diagnostic imaging modalities for cross-sectional imaging in dental implant planning are currently cone-beam computed tomography (CBCT) and multislice CT (MSCT).[6] Internal complexities of root canal ananomies necessitate the use cross sectional imaging in endodontics as well.
Computed tomography technology has been applied to the management of endodontic problems. Tachibana & Matsumoto (1990) published one of the first reports on the application of CT technology in endodontics. Many studies[6,7] have been done to evaluate image quality of MSCT in studying oral and maxillofacial region, in which investigator have concentrated on bony structures and other anatomical structures. Some studies have been conducted to measure the root canal volume and the dentinal thickness around root canal at different root levels using MSCT[4]. Using the remaining dentinal thicknesses before and after root canal instrumentations, following things are measured :- canal transportation[5,8], centering ability of instrument[5] and amount of dentine removed during instrumentation[9]. There was hardly any study done exclusively to evaluate the efficiency of MSCT in studying root canal anatomy with and without contrast media. Based on this fact, this study has been carried out.

**Multi Slice Computed Tomography:**

Multi Slice Computed Tomography (MSCT) is also known as Multi Detector Computed Tomography (MDCT). Computed Tomography (CT) was introduced into clinical practice in 1972 and revolutionised x-ray imaging by providing high quality images, which reproduced transverse cross sections of the body. Three-dimensional (3D) diagnostic imaging of the jaws has been of interest from the introduction of computerized tomography (CT) as a clinical tool.

Advantages of Multi Sliced Computed Tomography:-
1. Increased speed and volume coverage,
2. Excellent opportunities for dedicated 2D and 3D visualization

Disadvantages of Multi Sliced Computed Tomography:-
1. Occurrence of specific artifacts (multislice artifacts)
2. Increased contribution to patient dose due to reduced geometric efficiency and more prominent impact of the additional tube rotations necessary before and after data acquisition over the planned scan range.

**Mechanism of Action :-**

Computed tomography requires measurement, at different angles, of the dose profile of the fan shaped x-ray beam after attenuation by the patient. To achieve this a quickly rotating gantry containing an x-ray tube and detector array are used. In single slice CT, the curved detector array consists of about 800 – 1000 adjacent detector elements along the detector arc

**MSCT comparison with Dental X ray:-**

Traditional 2D x-rays give a limited amount of information presented in a pixel arrangement. Pixels can only produce images in one plane, along the x and y-axes. There is no depth dimension, or z-axis. Training coupled with experience in reading these images will allow the clinician to express an informed opinion about the anatomy presented, at best.

These images are also subject to various degrees of magnification and distortions. The degree of magnification can be accommodated due to the fact that the level of magnification is given for the images and this value can be used to formulate real measurements from measurements taken from the x-ray. Distortions cannot be computed as these errors occur due to variations of magnification in a given area. The posterior anatomy of the upper and lower jaws house critical structures such as nerves and sinuses, and unfortunately these areas are subject to the greatest amount of image distortion. Evaluating these areas with traditional dental x-rays is therefore limited.

Allowing differentiation of tissues with less than 1% physical density difference to be distinguished compared with a 10% difference in physical difference which is required with conventional radiography.

2D images still have their validity. Due to the fact that the image is created in a 2D pixel configuration, detail is often quite sharp. This sharpness and clarity of certain 2D x-rays allows for the detection of some diseases and conditions e.g. caries, whilst equivalent views of MSCT and CBCT images do not due to the z-axis depth dimension.
causing reduced sharpness and clarity.

Individually, the 2D x-rays are low in radiation but more often than not several images are needed to gain enough information. The combined dosage along with the quantity and quality of the images should be considered before the patient is irradiated.

The quantity of information in MSCT and CBCT scans compared to conventional x-rays is very different. In order to view 3D information, the raw DICOM data needs to be loaded into a 3rd party software program. The image can then be viewed slice-by-slice using cross-sectioning tools in Axial, Sagittal and Coronal planes. Conventional dental x-rays produce images on film, paper, or computer screen. The image cannot be sectioned or viewed in any other plane other than the one it is taken in.

Material and Methods:-

Sample Collection and Preparation:-
Freshly extracted teeth with fully formed roots were collected from the Department of Oral & Maxillofacial Surgery, ABMIDS.

Extracted teeth were disinfected using OSHA regulation.

[11]

Teeth Analysed :-
Total 9 teeth were analysed 2 maxillary molars, 4 mandibular premolars, 2 maxillary lateral incisors, 1 Peg shaped lateral incisor

Variables in sample:-
-One mandibular premolar was introduced with radiopaque dye inside pulp space.
-One peg shaped lateral was taken.

Study was conducted at K S Hegde Medical College and Hospital, Department of Radiology in MSCT section.

Teeth Mounting :-
Teeth were mounted in Alginate impression Material. Alginate impression material was mixed with proper proportion with water and poured into the impression tray. 9 study teeth were mounted into the unset alginate material and allowed to set.

Radio Opaque Dye :- Iopamiro 370 (BRACCO, Via Egidio Folli 50 Milan IT) containing Iopamidol with iodine 370 mg/ml was introduced into the root canal space of premolar.

Method To Introduce Dye:- Access cavity was prepared, necrotized pulpal tissue debrided and thorough irrigation done with 2.5% NaOCl solution followed by 17% EDTA solution (Ultradent Products Inc, South Jordan, UT). Then Radio opaque dye (Iopamidol) was introduced.

MSCT Scanning Procedure:-
Mounted teeth assembly was placed on the MSCT scanner stage. Images in all three plane Slices were captured.

MSCT imaging was performed using a Bright Speed (GE Healthcare Medical Systems, Tokyo, Japan) unit. The helical scan was set with X-ray tube voltage 120 kV and X-ray tube current 200 mA with 0.29 mm thick slices and a 16 i table pitch. Gantry tilt was 0.0. Displayed Field Of View (DFOV) was 150 mm and the scanned field of view (SFOV) in axial images was set at 250 mm in diameter. A series of axial images in DICOM files were saved on a portable HD.

Images can be viewed from the specialized software (Media Viewer, GE Healthcare Medical Systems, Tokyo, Japan) in which colour shades and gray scales can be adjusted for superior quality of the images.

Time required to capture all the images was 17 seconds.
Images were captured in three planes viz. Longitudinal Plane, Cross section and Coronal Plane.

Longitudinal Plane: - Number of images captured 215 Slice thickness 0.29mm
Cross section : - Number of images captured 87 Slice thickness 0.29mm
Coronal Plane:- Number of images captured 96 Slice thickness 0.62mm

Results:-
In longitudinal sections, pulp space anatomy extending from pulp chamber to the apical foramen can be well appreciated.

Pulp stone presented in pulp chamber can also be detected.
Canal exiting from eccentric position at root apex can be determined.
In cross sections, the geometric shape of pulp chamber and the tooth structure thickness present around the pulp can be measured.

Number of root canals present can be easily determined.

Position of root canal in the volume of root structure at each level can be determined.

Appearance of Contrast Media:

Being more radio-dense than normal tooth structure, like the metal objects, the contrast media attenuate the radiations with more efficiency. It leads to beam hardening [12, 13] To minimize metal artefacts in MSCT artefact suppression algorithms are used.[14]

Discussion:

Assembly which has been used in study is simple to fabricate. Set Alginate material is radiolucent. Therefore it didn’t attenuate the scanning radiation. Alginate is easy to manipulate.

Teeth were arranged in anatomical form in alginate to simulate in vivo teeth arrangement. In other studies, teeth were aligned with buccal surface in antero posterior position[4,9].

In the current study, we used MSCT, which provided a practical and non destructive technique for the assessment of canal morphology.

In the CT imaging system, by changing the viewing parameters, it was possible to show the images with more or less tooth density and detail. Once the images have been digitized, there were infinite ways in which they can be manipulated and viewed.[5]

Clearer images were obtained by changing the window level and window width in the image viewing software (Media Viewer GE Healthcare Medical Systems, Tokyo, Japan). Root canal anatomy was best appreciated with the preset “Vertebrae” setting of window width and window level.

Conclusion:

1. MSCT has lots of advantages: accurate positioning, non-invasive, reproducible, high resolution and the scanned image can truly represent the original structure.
2. The dental 3D perspective model with multi-slice spiral CT has good reducibility of shape.
3. It can truly present the characteristics of root canal system including the shape, the number, the main branches and the location of the relationship and can help dental practitioner to have the thorough recognition of the teeth morphology. But, the fine structures of collateral root canal and periapical section can not be showed insufficiently.
4. Multi-slice spiral CT with 3D reconstruction techniques can be used to study patient’s teeth from different perspectives and level to make the sufficiency of X-ray to provide more accurate information for clinical diagnosis.

Therefore the reconstruction of the dental 3D model with computed-assisted multi-slice spiral CT can truly reflect the morphological characteristics of teeth and has important value in the complex root canal therapy.

References:

10. (White & Pharaoh 2004)
Effect of additional acid etching on resin tag formation with self-etching adhesives - A scanning electron microscopy study

* Sunil M. Eraly, ** Mithra N. Hegde, *** Priyadarshini Hegde

Abstract

**Background and Objectives:** To observe the quality of resin tags formed at the resin-dentin interface produced by a fifth generation adhesive as compared to two self-etching adhesives and to evaluate the effect of additional acid etching on the resin tag formation of self-etching adhesives using Scanning Electron Microscopy.

**Materials and Methods:** Standardized Class I cavities were prepared in all forty six freshly extracted human maxillary and mandibular molars and randomly divided into: Group I: 35% Phosphoric acid etch followed by Excite DSC; Group IIa: Clearfil Liner Bond 2V; Group IIb: 35% Phosphoric acid etch and Clearfil Liner Bond 2V; Group IIIa: Adper Prompt; Group IIIb: 35% Phosphoric acid etch and Adper Prompt. All specimens were restored with a packable composite (Filtek P60), sectioned, gold sputtered and examined in a Scanning Electron Microscope. The results were tabulated and analyzed using Analysis of Variance (ANOVA) and Tukey Honestly Significant Difference test.

**Results:** The values obtained are listed in decreasing order:

- Resin Tag Penetration-
  - Group IIb: 40.18µm
  - Group IIIa: 28.23µm
  - Group IIIb: 25.13µm
  - Group I: 15.41µm
  - Group IIIb: 5.7µm

Statistical analysis of the data using ANOVA showed very highly significant values.

**Conclusions:** Dentin pretreatment with 35% phosphoric acid prior to application of self-etch adhesives resulted in thicker and longer resin tags.

**Keywords:** Dentin bonding agents; Total etch; Self-etch adhesive; resin tags; Scanning Electron Microscope.

Introduction

Adhesive dentistry has revolutionized restorative dental practice during the last four decades. The introduction of newer bonding systems, the sixth generation self-etching primers, being single step bonding agents, have reduced the chair side time to do a composite restoration. These bonding systems may be classified as mild, moderate or aggressive based on their ability to penetrate the dentin smear layer and their depth of demineralization into subsurface dentin. The more aggressive system completely solubilised the smear layer and smear plugs and formed hybrid layers with thickness approaching those of phosphoric acid conditioned dentin(1).

Scanning Electron Microscopy (2) is a commonly used method along with other various methods of observation like Transmission Electron Microscopy, Confocal Optical Microscopy. The combination of high resolution and extensive magnification range and high depth of field makes scanning electron microscopy uniquely suited for analyzing surfaces. It is an indispensable tool in material science research and development. Scanning electron microscopy has become the most popular and easiest tool to morphologically examine the bonding mechanism.

The aim of the present study was to evaluate using scanning electron microscopy, the quality of resin tags formed at the resin-dentin interface by self-etching adhesives and to evaluate the effect of additional acid etching on resin tag formation of self-etching adhesives. This in-vitro study is designed to test the hypothesis that the complete removal of smear layer prior to the use of self-etching adhesives would result in better resin tag quality.

**Objectives:**

- To observe the quality of resin tags formed at the resin-dentin interface produced by a total etch Fifth generation bonding agent and two self-etching Sixth generation adhesives.
- To evaluate the effect of additional acid etching on the resin tag formation of self-etching adhesives.

**Methodology:**

The present study was conducted at the Department of Conservative Dentistry and Endodontics, A. B. Shetty Memorial Institute of Dental Sciences, Deralakatte, Mangalore, Karnataka.
Memorial Institute of Dental Sciences, Mangalore; and Department of Metallurgy, Indian Institute of Sciences, Bangalore.

Forty-six, freshly extracted caries free human molars were collected, stored, disinfected and handled as per the recommendations and guidelines laid down by Occupational Safety and Health Administration (OSHA) and Centers for Disease Control and Prevention (CDC). All the teeth were examined and teeth with surface defects and cracks were eliminated. The teeth were pumice washed and then randomly distributed among groups. Protocols in cross infection control as per OSHA regulations in storing, surfacing and utilization were observed.

Standardized Class I cavity preparations were done in all the teeth using a No. 245 carbide bur with a high speed airrotor hand piece under air/water spray. The size of the preparation was made proportional to the dimensions of the tooth to minimize variations resulting from tooth size. The specimens were randomly divided into a control group and two experimental groups.

**Control Group:**

Group I (Six Specimens): (fig.1) All the prepared specimens in this group were etched with 35% phosphoric acid for 15 seconds and thereafter, rinsed for 15 second and air dried to remove excess water. Two coats of the single component total etch adhesive, Excite DSC was applied to the entire preparation and light cured according to manufacturer’s instructions.

**Experimental Groups:**

All the prepared specimens in this group were cleaned and air dried for 5 seconds to remove excess water.

**Group II (Twenty Specimens):**

Group II a (Ten Specimens): (fig 2) Clearfil Liner Bond 2V was applied to the entire preparation and light cured according to manufacturer’s instructions.

Group II b (Ten Specimens): (fig 3) Acid etching was done using 35% phosphoric acid for 15 seconds and thereafter rinsed for 15 seconds and air dried to remove excess water. Clearfil Liner Bond 2V was applied to the entire preparation and light cured according to manufacturer’s instructions.

**Group III (Twenty specimens)**

Group III a (Ten Specimens): (fig 4) Adper Prompt was applied to the entire preparation and light cured according to manufacturer’s instructions.

Group III b (Ten Specimens): (fig 5) Acid etching was done using 35% phosphoric acid for 15 seconds and thereafter rinsed for 15 seconds and air dried to remove excess water. Adper Prompt was applied to the entire preparation and light cured according to manufacturer’s instructions.

All the class I preparations were then restored with packable composite in an oblique incremental layering technique of 1 mm each, curing each layer for 40 seconds and stored under room temperature. They were sectioned using diamond impregnated disc, under running water, demineralized with 35% Phosphoric acid for 30sec, and then rinsed and deproteinized using 3% sodium hypochlorite for 10min, then rinsed and dried. The specimens were mounted on brass stubs gold sputtered in a gold sputtering machine and examined in a Scanning Electron Microscope (SEM). The results obtained were tabulated and statistically analyzed.

**Results:** (Fig. 6) The data of the present study showed that mean values for Group III b, Adper Prompt - self-etch adhesive with additional acid etching, displayed the highest depth of penetration of resin tags.

Group IIa, Clearfil Liner Bond 2V - self-etch adhesive, showed the least depth of penetration of resin tags.

Group I, bonded with Excite DSC a fifth generation dentin bonding agent showed mean length of resin tags close to Group III a, Adper Prompt - self-etch adhesive when used alone.

**Statistical Analysis:** The data of the present study subjected to statistical analysis showed that:

**Table I:** Inter-group comparison of mean length of resin tag penetration using Analysis of Variance (ANOVA) showed the values to be very highly significant.

<table>
<thead>
<tr>
<th>Groups</th>
<th>N</th>
<th>mean (standard deviation)</th>
<th>F</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>6</td>
<td>25.13 (2.3585)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>IIa</td>
<td>10</td>
<td>5.70 (0.5831)</td>
<td>477.50</td>
<td>0.001vhs</td>
</tr>
<tr>
<td>IIb</td>
<td>10</td>
<td>15.41 (1.4533)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>IIIa</td>
<td>10</td>
<td>28.23 (2.6441)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>IIIb</td>
<td>10</td>
<td>40.18 (1.9309)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Table II:** Inter-group comparison of mean length of resin tag penetration using Tukey Honestly Significant Difference Test showed very highly significant results in all inter-group comparisons except when Group I was compared to Group III a which showed statistically significant results.

<table>
<thead>
<tr>
<th>Dependent variable length</th>
<th>group(i)</th>
<th>group(j)</th>
<th>mean difference (i-j)</th>
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Effect of additional acid etching on resin tag formation with self-etching adhesives - A scanning electron microscopy study
DISCUSSION:

Today we are in an age of ‘Adhesive Dentistry’. Buonocore’s discovery of the acid-etch technique led to these changes in the present day practice of dentistry. Traditional mechanical methods of retaining restorative materials have been replaced to a large extent by tooth conserving adhesive restorative techniques.

Dentin is the fundamental substrate of restorative dentistry and its properties and characteristics are key determinants of nearly all restorative, preventive and disease processes of teeth. Improved understanding of the nature of the dentin has important consequences for today’s dental procedure and should lead to new methods to preserve and protect teeth and repair defects brought on by disease or trauma. Current research is focused on newer methods to produce a bond between restorative materials and dentin. Enamel has a long track record of being an excellent bonding substrate with composite resins(3). Number of studies has been carried out on enamel, proving it to be an excellent bonding substrate. However dentin bonding has been quite perplexing and little research has been conducted against the substrate.

Various bond strength studies have shown that self-etching adhesives are inferior to fourth and fifth generation bonding systems. D.H.Pashley(4) demonstrated etching patterns and bonds to enamel with these systems have been weaker compared to previous generations. E.A.Glasspoole et al(5) proved using Scanning Electron Microscopy and bond strength analysis that the bond to enamel of self-etching adhesives can be improved by pretreating enamel with 37% phosphoric acid. He further stated that the depth of resin penetration was also directly related to the bond strength. K.T. Jang et al(6) evaluated the effect of additional acid etching on resin tag formation of three self-etching primers and a one bottle adhesive. They reported that additional etching of dentin improved thickness and depth of penetration of resin tags.

In the present investigation we have made an attempt to compare ultramorphologically, one fifth generation bonding system and two self-etching adhesive systems and the effect of additional acid etching on resin tag formation of self-etching adhesives. The Scanning Electron Microscopic pictures that are produced were focused on the length and thickness of resin tags.

All the scanning electron microscopic pictures that are seen in published papers or product profiles that show long resin tags try to imply that this is desirable and contribute to bond strength. Although deep dentin exhibited more tags than superficial dentin, the bond strength of resin composite to deep dentin was generally lower than those made to superficial dentin (7,8,9). According to D.H.Pashley et al (10) resin tags only contribute to the bond strength if the resin actually bond to the wall of dentinal tubules. As most clinical cavity preparation include both superficial and deep dentin it would be desirable to have dentin bonding agents that bonded equally well to both types of dentin.

In this present invitro investigation we could record fairly deep resin tags penetration in two groups which...
 Included Excite DSC (25.13µm) (fig. 1) as a representative of fifth (total-etch) generation of bonding system and the self-etching adhesive Adper Prompt (28.23µm) (fig. 4). Clearfil Liner Bond 2V (5.7µm) (fig. 2) showed lesser resin tag penetration. The values obtained are in correlation with D.H. Pashley(1) who showed the more aggressive self etch adhesive has better depth of penetration. However after additional acid etching in the two self-etch adhesive groups we observed deeper resin tags with Clearfil Liner Bond 2V averaging 15.41µm (fig. 3) and Adper Prompt averaging 40.18µm (fig. 5). Ry Andia-Merlin(11) in their study have demonstrated resin tags upto 100 µm in length. Clearfil Liner Bond 2V demonstrated comparatively lower mean values as far as the depth of penetration of the resin tags was concerned. With Adper Prompt we could record maximum length of resin penetration while with Excite DSC we observed comparatively lower values. The additional observation made in the study was, that additional acid etching along with sixth generation self-etch adhesives resulted in thicker and longer resin tags which may contribute to additional bond strength. The increase in the thickness of resin tags and microtags observed in the SEM pictures may be a factor which indicates bonding to peritubular dentin within the dentinal tubules.

Ultramorphological findings with recent generation adhesives indicated evidence to fact that resin tags do contribute to the final bond strength due to the supplementary retention and sealing offered by the formation of microtags and lateral branching from the main tubules. Such microtags in lateral tubule branches show hybridization as well as a phenomenon defined as lateral tubule hybridization(12).

In our study, we observed lateral tubule hybridization with Excite DSC and Adper Prompt. After Additional etching, all specimens in self-etching adhesive groups showed microtags. Franklin R. Tay (13) studying effect of smear layer on bonding self etching primer to dentin concluded that self etching primers create thin hybrid layer that incorporate the smear layer. Their study demonstrated formation of thin hybrid layer in comparison to the smear layer thickness and both hybrid layer and smear layer may function as a single unit during loading without separation.

Concerning the result that are obtained we wish to emphasize that we have considered only two parameters that is length and thickness of resin tags and thickness of hybrid layer of two self-etching adhesives and fifth generation adhesive. We do not want to draw conclusion on the efficacy of a particular fifth generation dentin adhesive or self-etching adhesives by just looking into these two parameters. Before rank ordering a particular dentin adhesive system that are several methods of evaluation. Scanning Electron Microscopy is of known methods to compare and correlate bonds strengths studies. In all in-vitro studies there are several parameters involved including the collection of samples, freshness of the specimen, and method of storing, surfacing and utilization of these specimens.

In addition in-vitro conditions are different and lab in-vitro investigations are mostly dependant upon by the manufactures for highlighting the efficacy of their products. The self etching adhesives are fairly new in the commercial market, a system that is simple, efficacious with simple steps and less technique sensitive. However, commercially available dentin bonding system including the sixth generation self-etching adhesives have demonstrated number of weaknesses and both in-vitro & in-vivo studies. The quest for an ideal bonding system is on globally, to arrive at the ultimate bonding system which would seal the exposed cellular components within dentinal tubules and also result in biological compatible material.

More research is required to improve the bonding efficacy of self etching adhesives to different clinical substrates and to evaluate their long term success.

CONCLUSION:

In the present study a Scanning Electron Microscopic evaluation was carried out to demonstrate the depth and thickness of the resin tag penetration in dentin of the fifth generation bonding system and two sixth generation dentin bonding system and effect of additional acid etching on resin tag formation of self-etch adhesives, and the following conclusions were drawn.

Additional acid etching of dentin prior to application of self-etch adhesives resulted in improved quality of resin tags compared to self etching adhesives when used alone.

Bibliography:

Apexification and healing of large periapical lesion in a immature tooth by non surgical method using calcium hydroxide iodoform paste
- A case report

* Prasanth Dhanapal T., ** Sheena B Prasanth, ** Precymol Kuriakose

Abstract

A pulpless tooth with immature open apex and large periapical lesion is difficult to manage. Usually such lesions are treated by a combination of conventional endodontic therapy followed by surgical protocol including sealing the open apex with materials. Surgical methods are opted as it is widely believed that large lesion at the periapex do not heal by conventional root canal therapy. There is no scientific evidence for this belief. Surgical protocol also has many associated complications and has lower patient acceptance level. Conventional endodontic therapy with usage of chemomechanical methods to clean and shape the canal and use of medicaments for disinfection of the canal can create a favourable environment for healing of the periapical lesion and closure of apex. This article is a report of a case of large periapical lesion in a pulpless teeth with immature apex treated with calcium hydroxide iodoform mixture paste with good results of healing of lesion and formation of a calcific barrier as evidenced radiographically. This report suggests that pulpless teeth with immature apex and large periapical lesions could respond favourably to nonsurgical endodontic treatment using medicaments.

KEY WORDS: Apexification, Immature apex, Periapical lesion, Calcium hydroxide paste, Calcium hydroxide iodoform paste.

Introduction:

Untreated pulpal necrosis often leads to extension of bacteria and their by-products from the pulpal space to the periapical region leading to formation of periradicular lesions. Such periapical lesions can also happen with teeth with immature apex. Some form of trauma or involvement of the pulp by caries can cause cessation of root end development resulting in open apex. Open apex makes the management of associated periapical lesion difficult for the clinician as it would be difficult to instrument and obturate the canal without an apical stop (1). In such cases the management should be directed towards two objectives. First healing of the periapical lesion. Secondly, obtain an apical barrier by apexification (2) for facilitating instrumentation and obturation of the canal. In the past large periapical lesions were mostly managed by a combination of endodontic treatment followed by periradicular surgery including the use of some materials to create a barrier at the apex as it was perceived that large lesions would not heal by conventional means. These beliefs are not supported by scientific evidence. Surgical intervention is also associated with surgical complications and has lower acceptance from the patient. Scientific evidence supports the fact that open apex and large periapical lesion is amenable to conventional endodontic therapy employing proper chemomechanical means to disinfect the canal along with the use of intracanal medicaments. Routine endodontic therapy using medicaments facilitates apical calcific barrier formation and creates a favourable environment for the periapical lesion healing.

Complete cleaning and disinfection of the root canal systems and its ramifications has a direct impact on the healing of large periapical lesions. It is proved that large periapical lesions would not heal if all the infectious material from the root canal space is eliminated. Total disinfection of the root canal and its inaccessible is made possible by chemomechanical means employing irrigants with antibacterial properties during the preparation of the canal. In clinical situations when there is need to disinfect the canal, intracanal medicaments with proven antibacterial action can be used as an interappointment medication. Calcium hydroxide is one of the popular intracanal medicament used for disinfection of the canal system. Calcium hydroxide in the canal creates a favourable environment for healing of the periapical lesion (3,4). In case of pulpless immature teeth calcium hydroxide as a medicament disinfects the canal and provide the stimulus for calcific bridge barrier formation at the apical region. This process called as apexification (5, 6) would be of importance in facilitating instrumentation of the canal and later obturation of the canal to the correct working length.

The following case report describes apexification in an immature non vital tooth with a large periapical lesion
employing non surgical conventional endodontic treatment. Calcium hydroxide iodoform paste was used as intracanal medicament. 1 year radiographic follow up was evaluated and uneventful healing of large periapical lesion was observed along with definitive radiographic evidence of calcific barrier formation.

Case report:

A 12 year old female reported to our dental clinic with a complaint of severe pain and swelling in relation with the upper anterior teeth since 3 days. The patient also complained about her inability to chew food well and the upper front teeth was hurting on touch. The parent gave a positive history to trauma 5 years back which was not attended to at the time of trauma. The tooth was asymptomatic till the present episode of pain and swelling. On extra oral examination there was no swelling. Intraorally there was a non fluctuant swelling in the periapical region in relation to upper left central incisor (21- FDI Notation) and lateral incisor (22- FDI Notation). 21 was tender to touch and had pain on percussion. Grade II mobility was observed on 21. 22 was non tender to percussion and no mobility was observed. Pulpal necrosis of 21 was confirmed using Endo I.C.E (Hygenic, OH, USA) refrigerant spray. 22 was responding normal to thermal testing. Intraoral periapical radiograph (IOPA) of 21, 22 region revealed a large periapical radiolucency about 4-5 mm in diameter in relation to 21 along with open apex. (FIG 1)

The different treatment options and the prognosis were discussed with the parents. The patient preferred to attempt non surgical conventional endodontic therapy to consider for surgical procedure if the symptoms do not get resolved or if the lesion donot regress after a time period.

Routine endodontic therapy was initiated by access without anaesthesia and the canal was negotiated, instrumented using the conventional step back technique using K –Flexofile (Dentsply Maillefer, Ballaigues, Switzerland) files. There was pus drainage from the canal and was allowed to drain for 30 minutes. 3 % Sodium hypochlorite was used as the main irrigant between files and the final irrigation was done with normal saline. The cleansed canal was visually observed for drainage of pus and when no further drainage was observed a closed dressing with Zinc oxide eugenol cement (DPI, India) was provided. The patient was prescribed antibiotic and recalled after a day.

On recall the patient reported relief of pain and considerable reduction in the swelling. The dressing was removed and the canal was observed for any drainage. The canal was reinstrumented gently upto size ISO 50 with 3% sodium hypochlorite as the main irrigant and normal saline as the final irrigant. The canal was dried using absorbent paper points (Dentsply Maillefer, Ballaigues, Switzerland) and the entire root canal was filled with calcium hydroxide paste containing iodoform and barium sulphate (Calform RC, Ammdent, India). The barium sulphate provides the radiopacity to evaluate the fill and later helped to compare the density of the fill. The medicament was gently injected into the canal employing finger plugger (Mani Inc, Japan). A closed dressing was provided with zinc oxide eugenol cement. A post procedure IOPA ruled out any gross overextension of the radio opaque material (FIG 2). The patient was recalled after 4 weeks with instructions to report if there is any discomfort or symptoms. At 4 weeks recall an IOPA evaluation was done. The IOPA revealed radiographic signs of the lesion regressing and the patient reported no discomfort or symptoms during the review period. (FIG 3) The calcium hydroxide in the canal was flushed out using normal saline and the canal reinstrumented to remove the material on the walls. The canal was dried, calcium hydroxide was repacked into the canal and a closed interim dressing was provided. The process of medicament change was done once a month for 6 months with radiographic evaluation every 2 months. (FIG 4)

At the 6th month recall visit IOPA evaluation showed formation of radio opaque band at the apical zone suggestive of calcific barrier and almost total regression...
of the periapical lesion. The calcium hydroxide was flushed out and the physical exploration of the canal using gutta-percha revealed a definitive stop at the apical zone. Radiographic evidence of calcific bridge formation along with clinical stop was correlated as success of apexification. The root canal was obturated using conventional lateral condensation technique using gutta-percha points (Dentsply Maillefer, Ballaigues, Switzerland). A post obturative IOPA was made, which showed definite radiographic evidence of periapical healing. Calcific bridge was evident radiographically. (FIG 5) Radiographic evidence of trabecular pattern at the area where the periapical lesion was present earlier was seen. This finding is suggestive of healing periapical lesion and calcific barrier formation by apexification. This can be correlated clinically as successful outcome of non surgical conventional endodontic therapy using calcium hydroxide iodoform paste in a pulpless tooth with immature apex and large periapical lesion(7)

Discussion:

Pulpal necrosis is the sequela of pulpal damage due to any cause. Bacteria and their infectious byproducts in the pulp extend into the periradicular area through any of the portals of exits from the pulp space. The egress of the bacteria and their virulence factors often leads to development of periapical and periradicular lesions. These enlarge if not attended on time. The same sequence can also happen when the pulp becomes necrotic before the root end formation and maturation has taken place. This open apex immature tooth presents a larger treatment problem, as it is difficult to instrument the canal to the working length and to obtain an apical stop needed for instrumentation and obturation. It is also difficult to confine the medicament and core material or sealer within the root. Conventional endodontic therapy followed by surgical methods to remove the infected area and to surgically create an artificial barrier at the open apex is the most opted treatment methodology. It was widely believed that large lesions would not heal if conventional endodontic therapy alone is performed. Surgical procedure is also associated with many complications of surgery and has poor acceptance of the procedure by the patient.

Proper cleansing of the root canal system using antibacterial irrigants and disinfection of the root canal system using medicaments has proved to eliminate any residual bacteria within the canal. Calcium hydroxide is the most popular intracanal medicament used in endodontics for a wide variety of situations. Calcium hydroxide has been reported to aid in healing of periapical lesion when used in teeth with periapical lesion of endodontic origin (8) Use of interappointment intracanal medicaments like calcium hydroxide is known to facilitate a conducive environment for healing of periradicular lesion. The placed medicament also induces formation of calcific barrier at the apical zone and the process of formation of calcific barrier by using a medicament in the canal is termed as apexification (9). The action of calcium hydroxide is by its ionic action. On application calcium hydroxide dissociates into calcium ions and hydroxyl ions. The hydroxyl ion by virtue of its alkaline pH acts on bacteria cytoplasmic membrane reducing the viability of the bacteria and hence aids in achieving disinfection of the canal. When the canal is disinfected adequately the biological action of calcium hydroxide induces mineralization (10) and thereby tissue repair by activating alkaline phosphatase.

Conclusion:

In present case an immature tooth with open apex and a large periapical lesion was treated by conventional root canal therapy using calcium hydroxide as inter appointment intracanal medicament. This methodology has proved successful in promoting healing of a reasonably large periapical lesion well as formation of a calcific barrier at the apical region. This confirms the earlier hypothesis that even large or moderately large periapical lesions would respond favourably to non-surgical treatment (11). It also confirms the concept that use of calcium hydroxide also induces formation of apical calcific barrier in immature teeth. Therefore conventional endodontic therapy with use of calcium hydroxide intracanal medicament must be integral part of any treatment plan for pulpless teeth with immature apex and pulp associated periapical lesion before any invasive surgical measures are planned (12)

References:
Non-surgical retrieval of a separated instrument extending beyond the peri-radicular space: A case report

* Navneet Godar, ** Pooja Lalit, *** Ravi Varma

Abstract

Fracture of endodontic instruments within root canals is not an uncommon incident in endodontic therapy. The prognosis of such teeth depends upon preoperative condition of peri-radicular tissues and instrument retrieval. An attempt to remove separated instruments should be undertaken in every case. There have been many different devices and techniques developed to retrieve fractured instruments during endodontic procedures. This report describes a case where a separated instrument extending beyond the peri-radicular space of the maxillary right central incisor was successfully retrieved using instrument removal system followed by conventional obturation using gutta-percha points with lateral compaction method.

Keywords: Non-surgical retreatment, separated instrument, peri-radicular space, instrument removal system.

Introduction

In the practice of endodontics, clinicians may encounter a variety of unwanted procedural accidents and obstacles during routine therapy, at almost any stage of treatment (1). The separation of instruments during endodontic therapy is a troublesome incident, and it incidence ranges from 2% to 6% of the cases investigated (2, 3, 4).

The most common causes for file separation are improper use, limitations in physical properties, inadequate access, root canal anatomy, and possibly manufacturing defects (5). The separated fragment blocks the access to thorough root canal cleaning and shaping procedure apical to the level of separation or irritates the periapex when it juts out of the root apex. This is significant during endodontic therapy, as it affects the final outcome (6). Every attempt should be made to remove the separated fragment or bypass it, followed by adequate cleaning and shaping and incorporating it into the final obturation.

Management of a separated instrument requires an orthograde or a surgical approach. The orthograde approaches are (a) attempt to remove the instrument; (b) attempt to bypass the instrument; and (c) prepare and obturate to the fractured segment (7).

The removal of separated instruments from the root canal is, in most cases, very difficult and often ineffective. Various new devices such as operating microscope, ultrasonic devices, masserann kit, endo extractor, wire loop technique, the canal finder system, instrument removal system (IRS) or the tube and hedstrom file technique may result in easier and controlled removal of fractured instrument (5).

The present case report describes the successful non-surgical retrieval of a separated instrument extending beyond the peri-radicular space using instrument removal system (Dentsply Tulsa Dental; Tulsa, Oklahoma).

Case report

A 30-year-old female patient reported to the Department of Conservative Dentistry and Endodontics, Jaipur Dental College, Jaipur, India, with a history of pain in maxillary right central incisor. The dental history revealed the root canal treatment had been performed 10 years back. On intraoral examination, tooth 11 was tender on percussion and palpation. A periapical radiograph revealed the presence of a metal fragment in the root canal, extending beyond the peri-radicular space (Fig. 1A). The case was diagnosed as symptomatic apical periodontitis. After taking the clinical and radiographic findings into consideration, it was decided to retrieve the fragment by non-surgical technique and thereafter, complete the root canal treatment.

Local anesthesia was administered and the tooth was isolated with a rubber dam. A conventional access cavity was refined to facilitate access for instrumentation. The length of the working space to the coronal end of the fragment was determined radiographically by means of X-ray grid (Fig. 1B). Radicular access to the coronal end of the fragment was straightened by funneling the root canal with sequential use of gates–glidden drills. Ultrasonic instruments were used to circumferentially trephine, sand away dentin, and to expose 2-3 mm of the obstruction. The
Bonded composite (Z350; 3M ESPE, St Paul MN) was used. After the microtube has been positioned, the same color coded screw wedge was inserted and slid internally through the microtube’s length until it contacted the obstruction. The fragment was engaged by gently turning the screw wedge handle counter clockwise. A few degrees of rotation will serve to tighten, wedge, and displace the head of the obstruction through the microtube window. When engaged, the fragment was unwound and removed by rotating the microtube and screw wedge assembly counter clockwise (Fig. 1C, D).

Following retrieval of the fragment, the root canal was instrumented with stainless steel K-files (Dentsply-Maillefer, Ballaigues, Switzerland). During the instrumentation the canal was irrigated copiously with 2.6% sodium hypochlorite (NaOCl) and distilled water solution by using endodontic needle. After drying with sterile paper points ((Dentsply-Maillefer, Ballaigues, Switzerland), the canals were dressed with calcium hydroxide paste (Calciex, Nihon Shika Yakuhin Co, Japan). The access cavity was sealed with a temporary filling material (IRM Caulk; Milford, DE). When the patient returned after 2 weeks, the tooth was asymptomatic. Tooth material (IRM Caulk; Milford, DE). When the patient returned after 2 weeks, the tooth was asymptomatic. Tooth removal of tooth 11 was filled with gutta-percha (Dentsply-Maillefer, Switzerland) and AH plus sealer (Dentsply, DeTrey, Konstanz, Germany) using a lateral compaction technique. Bonded composite (Z350; 3M ESPE, St Paul MN) was used to seal the access cavity (Fig. 1E). A 6-month recall showed no sensitivity to percussion or palpation and soft tissues were healthy.

Discussion:

Intra canal separation of instruments usually prevents access to the apex, impedes thorough cleaning and shaping of the root canal, thus may compromise the outcome of endodontic treatment and reduce the chances of successful retreatment (2, 8, 9).

Successful removal of such obstructions relies on factors such as the position of the instrument in relation to the canal curvature, depth within the canal, and the type of fractured instrument (10, 11). The more apical the location of the fractured instrument the greater the potential for root perforation (12) and the lower the fracture resistance of the root after removal of the instrument (13). Straight-line access is mandatory for successful removal of instruments (14), but conservation of tooth structure is paramount to the tooth’s resistance to fracture. An attempt to bypass a fractured instrument should always be initially considered because it can often be successful (6), particularly in those situations where the root has more than one canal and if they join before the apical foramen.

Another consideration is that the prognosis is reduced because microbial control is compromised when instrument breakage occurs in the early stages of canal preparation without at least minimal debridement, either short of the apex or beyond the apical constriction, and the instrument cannot be bypassed (1). On the other hand, prognosis is favorable in cases where canals have been usually adequately debride leading to sufficient microbial control, where larger instruments have fractured in the apical third or where the broken fragment has been satisfactorily bypassed (1, 15).

In the present case, extrusion of the fractured instrument was seen in the peri-radicular space and the patient was symptomatic. Decision was made to perform orthograde retreatment rather than surgery.

The retrieval of fractured instruments from root canals has been largely reported in the literature, and many devices and methods have been proposed to accomplish that (16-20). In the past chemicals such as hydrochloric acid, sulfuric acid, and concentrated iodine-potassium iodide were used in an attempt to dissolve the metal obstruction (8). In more recent times, specialized devices and techniques have been introduced specifically to remove fractured instruments such as the masserann kit, endo extractor, wire loop technique, the Canal Finder System, long Shank burs (5, 14), fine ultrasonic tips and other innovations such as staging platforms (10) and the Instrument Removal System (21). The problems associated with these devices include excessive removal of root canal dentin, ledging, perforation, limited application in narrow and curved roots, and extrusion of the fractured portion through the apex (8, 15).

In this case Instrument Removal System was used to...
retrieve the fractured instrument as this technique is conservative of dentin and less stressful for the operator (10, 12, 13, 15). The locking mechanism of the microtube provides considerable retention in gripping and dislodging an obstruction, which is tightly wedged in the canal. The scope for its modification, usage along with ultrasonics and surgical operating microscope makes it more effective in selected cases (2).

**Conclusion**

Prevention of the instrument separation is the best strategy to avoid any stress and anxiety associated with it. In case of separation, safe retrieval or by passing should be carried out. The ability to non-surgically access and remove a separated instrument will be influenced by the diameter, length and position of the obstruction within the canal. Additionally, the potential to safely remove a separated instrument is guided by the anatomy, including the diameter, length, and curvature of the canal.

**References**


**ERRATUM**

In the issue of Jcaesok October 2011, Vol 1, no. 2, page no 91 the following image was inadvertently left out of the references list. The authors would like to acknowledge the same and would like to credit the image to the following article.


The authors and the editorial team at JCaesok also regret the inconvenience caused to the authors and the publication.
Mandibular cyst of systemic origin

* Raji Sreekumar, ** Sreekumar

Abstract

Cystic lesions of the oral cavity always presents challenge to the clinicians in diagnosis and treatment planning. Systemic illnesses are increasing in incidence. Hence clinician should have a clear picture about cystic lesions that can occur in systemic disorders. Here we report a case of mandibular cyst in an anaemic patient.

**KEY WORDS:** mandibular cyst, haemorrhagic, anaemic

Introduction

Iron deficiency Anaemia is a condition where a person has inadequate amounts of iron to meet body demands. It is a decrease in the amount of red cells in the blood caused by low level of iron in blood. Iron deficiency anemia is usually caused by a diet insufficient in iron or from blood loss. Blood loss can be acute as in hemorrhage or trauma or long term as in heavy menstruation. Iron deficiency anemia is the most common form of anemia. About 20% of women, 50% of pregnant women, and 3% of men are iron deficient. Some people with iron deficiency anemia always feel cold. They feel cold because iron plays a role in keeping the body temp. In some haematological disorders patient may have associated symptoms in the oral cavity (1). Exact cause for the lesion has not been proved.

Pathologic cyst is defined as well circumscribed epithelium lined cavity containing fluid or semi fluid contents.

Intra orally cysts occurs due to developmental & non – developmental origin (2,3). It can also be categorized as odontogenic and non-odontogenic origin. In some cysts it won’t have true cystic lining. Usually these type are referred to as idiopathic bone cavity or hemorrhagic cyst(3,4). It is a rare disorder of jaw bones, comprising only 2% of all bone cysts affecting this area. It is an asymptomatic, slow growing, usually non expansile lesion commonly diagnosed incidentally during routine radiographic examination of jaw bones. Etiology of this clinical entity is not clear and trauma has not been definitely determined to be the cause. It occurs mainly in children and young adults, and the body of mandible is the most common site. On the basis of the literature, opinions concerning the etiology, pathogenesis and treatment of this disorder has been presented. A typical case of incidentally diagnosed mandibular cyst of 26 year old anaemic patient has been discussed.

Case history

26 year old female patient was reported to the department with complaints of pain and swelling intra orally. Associated complaints of the patient were fever, giddiness, weight loss and recurrent throat pain menorrhagia. She was advised to undergo following investigations, routine blood investigations and thyroid function test. Laboratory test results are-

1. bleeding time- 2 minutes 30 seconds
2. clotting time- 7 minutes
3. total WBC count 9600/mm3
4. E.S.R- 15mm/hr
5. differential count- neutrophils -56% lymphocytes-43% Eosinphils-1%
6. Hb-
7. platelet count 9.3g/dl, 3.32 lakh/mm3
8. T4- 11.3-N
9. TSH- 5.0>
10. T3 178.2 N
11. rheumatoid factor negative
She was provisionally diagnosed as having iron deficiency anemia & hypothyroidism by physician.

Intraoral findings

On palpation tenderness of alveolar mucosa especially over 36 region.(fig.1&2). Intra oral examination doesn’t reveal any obvious dental causes. But to rule out the possibility of hidden causes she was advised to take ortho pantograph. O.P.G. revealed well defined radiolucent lesion over 36 region, with lamina dura intact and clear sclerotic border of lesion. (fig.3). Differential diagnosis of mandibular cyst given. T-loxof-500mg, T-emabzen-D, T-opal-20mg were prescribed for acute symptoms. Reviewed the patient after 5 days. Aspiration cytology was done as the patient was symptomatically improved. Aspirate was brownish serous fluid. We planned to do curettage/enucleation under G.A.electively.

Surgical management

After taking all precautions surgery was performed under G.A.Muco periosteal flap revealed perforation of lingual cortex, absence of encapsulation and 36 found to be in hanging on position in the lesion. Lesion was curetted,
inferior alveolar neuro vascular bundle sacrificed due to involvement in the lesion. Wound closed with 4-0 vicryl.
Post surgical instructions followed, recovery was uneventful. Contents of lesion was sent for processing and histopathological examination. Root canal treatment for 36 was done. fig [4&5]

Histopathology
Histopathology of fragments of brownish tissue revealed irregular piece of fibro-collagenous tissue. It does not show any atypia of squamous epithelium, inflammatory cells are present with adherent haemorrhagic fibrinous material. Bone trabeculae shows normal structure. Provisional diagnosis –haemorrhagic cyst of mandible with c/inflammation, c/osteomyelitis. Patient continued the review check ups and supportive therapy such as iron, folic acid, eltrocin. Instructions were given to do followup check ups every month with Endocrinology dept.

Discussion
Mandibular cysts are of common occurrence. Original causes for the lesion are diverse in nature. Those associated with systemic illness shows varying presentation. Most of the cases are asymptomatic. Unless the patient present with specific intra oral complaints lesion get unnoticed. The lesion appears to increase in size by a steady expansion produced by progressive infiltrating oedema and restriction of venous drainage. Expansion ceases once lesion reaches cortical layer. In some patients history of trauma bring out the underlying lesion. But there is no confirmatory studies in that matter. Cyst like lesions in haematological disorder is are mainly due to the disturbance in hemopoietic system(6,7). Hemorrhagic lesions get encapsulated and become symptomatic when it is infected. Resolution of lesion occurs only if the primary cause is treated.

Conclusion
This gives emphasis for formulating diagnosis in cystic lesions based on origin of lesion. Until we arrive at proper diagnosis, resolution phase will be delayed and chances for non healing is also more. If the clinician have definitive diagnosis, flow chart for treatment will be an easy task. Cysts of systemic origin shows faster resolution once supportive treatment is taken along the definitive treatment. Importance of treating such lesions occurs in the fact that vascular lesions may invite unnecessary complications. Guidelines in the management of cystic lesions of systemic origin- 1.identify the underlying systemic illness. 2.appropriate treatment for oral lesions. 3.supportive corrective therapy. 4.regular follow up check up.

References
“Section to save”-hemisection—case reports

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Abstract

Hemisection as a treatment option is indicated in cases with both endodontic and periodontal infection. This is one of the multi disciplinary situations where the branches of endodontics and periodontics merge to salvage the tooth. This article highlights two clinical cases where endodontic-periodontic infection in mandibular molars was successfully managed by hemisection and subsequent rehabilitation.

Key Words: Hemisection, Root resection

Introduction

Endodontic–periodontic lesions present great challenges to the clinician as far as diagnosis and prognosis of the involved teeth are concerned. The prognosis is largely dependent on the amount of bone available to retain the tooth. Therapeutic measures performed to ensure the retention of such teeth vary in complexity. The treatment may involve combining restorative dentistry, endodontics and periodontics so that the teeth are retained in whole or in part. (2)

The term tooth resection means—excision and removal of any segment of the tooth or a root with or without its accompanying crown portion. (3) Various resection procedures include- root amputation, radisection, bisection and hemisection.

Root amputation—refers to removal of one or more roots of multirooted tooth while other roots are retained.

Radisection—newer terminology refers to removal of roots of maxillary molars.

Bisection—refers to separation of mesial and distal roots of mandibular molars along with its crown portion, where both segments are then retained individually.

Hemisection—refers to removal or separation of root with its accompanying crown portion of mandibular molars. (4)

Common indications of hemisection are: Prosthetic failure of abutments within a splint, cases of endodontic failure, vertical fracture of one root, severe vertical bone loss involving only one root of multi-rooted teeth and in cases of severe periodontal destruction.

Contraindications for hemisection are: Cases with inoperable canals and fused root, and cases with strong alternative abutment. (4)

This paper presents 2 case reports of hemisection with 6-month follow up.

Case Report -1

A 58 year old female patient reported to our department with the complaint of pain and mobility of right mandibular first molar.

On examination, the tooth was tender on percussion and revealed grade 2 mobility. On periodontal probing, there was a 6 mm deep periodontal pocket around the distal root.

On radiographic examination, severe vertical bone loss was evident surrounding the distal root and involving the furcation area. The mesial root had adequate bone support (Fig. 1). The treatment planned was endodontic therapy with hemisection of the distal root.

The mesial canals were accessed, chemomechanically prepared by stepback technique and obturated by lateral condensation method. The chamber was filled with amalgam to maintain a good seal and allow interproximal area to be properly contoured during surgical separation.

Under local anesthesia, full thickness flap was reflected after giving a crevicular incision from first premolar to second molar. Upon reflection of the flap, the bony defect along the distal root could be visualized. All chronic inflammatory tissue was removed with curettes to expose the bone. The tooth was resected with a long shank tapered fissure carbide bur up to the furcation area. A fine probe was passed through the cut to ensure separation (Fig. 2). The distal root was extracted and the socket was irrigated with sterile saline to remove bony chips and amalgam debris (Fig. 3). The furcation area was trimmed to ensure that no spicules remained to cause periodontal irritation. The extraction site was debrided and the flap was repositioned and sutured with 3/0 black silk sutures. The occlusal table was corrected to redirect the occlusal forces along the long axis of the mesial root.

Case Report -2

A 52 year old male reported to the department with pain and mobility of left mandibular first molar. Clinical examination revealed that the tooth was tender to percussion, had grade 2 mobility and there was a 4mm deep pocket around the distal root.

Radiograph of the tooth showed caries extending into the distal root and vertical bone loss up to the furcation...
area. The bony support of mesial root was intact (Fig. 4). Endodontic therapy and hemisection were performed similar to the previous case and the patient was scheduled for follow-up.

Discussion

With an increasing desire to retain natural teeth, root resection procedures have received wide acceptance as a conservative and dependable treatment option. Success of these procedures depends to a large extent on proper case selection. Investigations of root -resected or hemisected teeth have provided evidence that such teeth can function successfully for long periods.(6)

However, it is important to consider certain factors before deciding to undertake these procedures.(2) These factors include the extent and pattern of bone loss (advanced bone loss around one root with acceptable level of bone around the remaining roots), location of root furcation, root length, root divergence, ability to eliminate the osseous defect and endodontic as well as restorative considerations.

In the present case reports, the patients' clinical features and radiographs showed that the lesion was of primary periodontal origin. In both the cases the mesial root had adequate bone support. Considering this, hemisection was chosen as a treatment option, with the objective of preserving the distal root. No endodontic or restorative complications were anticipated.

An improperly shaped occlusal contact area could convert acceptable forces into destructive forces and predispose the tooth to trauma from occlusion. To avoid this in the reported cases, occlusal tables were reduced in size and repositioned more favorably.

In the first case, the restoration of the pulp chamber with amalgam had the potential for contamination during hemisection procedure. With this consideration, the chamber was filled with composite resin in the second case.

Hemisection procedure has few disadvantages. As with any surgical procedure it can cause pain and anxiety. Root surfaces that are reshaped at the site of hemisection are more susceptible to caries. This re-emphasises the need for periodic review of the patient and also maintenance of good oral hygiene.

Conclusion

The success of any procedure depends largely on case selection, patient acceptance and understanding of the limitations and complexities of the procedure. A thorough treatment plan and expertise in execution are mandatory for long term success in a case rehabilitated by hemisection.

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Bio Ceramic Sealers - Game changer in Endodontic Obturation

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Abstract

The current trend in the development of any endodontic filling is to eliminate any microspaces existing between the root canal wall and filling material. The use of bioceramic based sealer blessed with features like osseo conductivity, hydrophilicity, adhesion appears to be an amicable approach to eliminate microspaces. Bioceramic based sealers are delivered to the apical one-third on the principle of capillary condensation technique after preparing a coronal reservoir. Bioceramic based material have nanosized particle, low contact angle, good flow properties to seal the lateral canals, reinforce the root and to eliminate the root fracture. This article evaluate the establishment of endodontic synchronicity, physical properties, bonding mechanism and its application in endodontics.

Introduction:

The science associated with bioceramic technology has generated a number of biocompatible ceramic materials specifically designed for use in medicine and dentistry. Systematic research of ceramics for use in biomedical applications began in the early 1970's and over the past 40 years, the application of a variety of ceramics in biomedicine has greatly expanded. “Bioceramics” include alumina and zirconia, bioactive glass, glass ceramics, calcium silicates, coating and composites, hydroxyapatite and resorbable calcium phosphates and radiography glasses.(1)

Bioceramics are widely used for orthopedic applications such as joint or tissue replacements and for coating metal implants to improve their biocompatibility.1 Additionally, porous ceramics such as calcium phosphate based materials have been used for filling bone defects. Even some basic calcium silicates such as ProRoot MTA (DENTSPLY) have been used in dentistry as root repair materials, apical retrofills and at present as root canal sealers.

Physical properties of Bioceramics:

The properties associated with bioceramics make them very attractive to both medicine and dentistry. In addition to being nontoxic, bioceramics can be classified as:

a) Bioinert: noninteractive with biological systems.

b) Bioactive: durable tissues that can undergo interfacial interactions with surrounding tissue.

Expanded use of bioceramics in endodontics is associated to physical properties. Bioceramics are exceedingly biocompatible and they are chemically stable with biological environment. They do not shrink upon setting. Furthermore it will not result in a significant inflammatory response if an’ overfill occurs during the obturation process. A further advantage of this material itself, is its ability (during the setting process) to form hydroxyapatite and ultimately establish a chemical bond between dentin and appropriate filling material.

Advantages compared to other sealers:

Advantages are: enhanced biocompatibility, the fact that it does not shrink, it does not resorb (which is critical for a one-cone technique), its high pH (12.8) during the initial 24 hours of the setting process (which is strongly anti-bacterial), its excellent sealing ability, the fact that it sets quickly (3 to 4 hours) and its ease of use (particle size is so small it can be used in a syringe).(3)

The high pH makes this material very antibacterial during its setting period (the pH will decrease over the next few days.) In fact, a study by H.Zhang etal, noted significantly that the bioceramic sealer killed all bacteria within 2 minutes of contact. The authors proceed to explain that its antibacterial effect might be a combination of high pH, hydrophilicity, and active calcium hydroxide diffusion.(5)

The introduction of a bioceramic sealer (EndoSequence bioceramic sealer) allows us, for the first time, to take advantage of all the benefits associated with bioceramics but to not in limiting its use in root repairs and apical retrofills. Owing to recent nanotechnology developments (the particle size of BC Sealer is so fine [less than 2 ìm], it can actually be used with a.012 inch capillary tip).(8)

This material is specifically designed as a nontoxic calcium silicate cement. In addition to its excellent physical properties, the purpose of bioceramic sealer is to improve the convenience and delivery method of an excellent root canal sealer while simultaneously taking advantage of its bioactive characteristics (it utilizes the
Bioceramic Sealer (and root repair material) Bonding Mechanism

The main component of dentin is hydroxyapatite, which has a hydroxy-groups. Then the setting reaction is initiated which produces a composite of calcium silicate hydrogel and hydroxyapatite. The calcium silicate hydrogel will form a chemical bond with the hydroxyapatite on the dentinal walls.(5) Therefore, both the compounds will form strong chemical bonding with the dentin hydroxyapatite. When the smear layer is removed, the fresh hydroxyapatite structure of the dentin is in direct contact with the sealer, which creates the chemical bonding. This chemical bonding is, as well, accompanied by the micromechanical bonding of the nanoparticles described.

Also, the bioceramic sealer will bond to a coated cone with glass ionomer particles (Activ GP). The main composition of glass ionomer is calcium aluminate and calcium silicate compounds. The calcium silicates in bioceramic sealer hydrate with water to produce calcium silicate hydrate gel, which forms a chemical bond with the calcium aluminate and calcium silicate compounds on the surface of the Active GP. This in addition to the micromechanical bond created by the interlocking of the nanoparticles described.

Technique for Bioceramic use as an Endodontic Sealer

The technique with this material is straightforward. Simply remove the syringe cap from the sealer syringe. (Fig.1) Then attach an intra canal tip, or a capillary tip of your choice, to the hub of the syringe. The intra canal tip is flexible and can be bent to facilitate access to the root canal. Also, because the particle size has been milled to such a fine size, a capillary tip (such as a. 012 inch) can be used to place the sealer.

Following this procedure, insert the tip of the syringe into the canal no deeper than the coronal one third. Gently and smoothly dispense a small amount of sealer into the root canal by compressing the plunger of the syringe. Using a No. 15 hand file or something comparable (such as the master cone), lightly coat the canal walls with the existing sealer in the canal. Then coat the master gutta-percha cone with a thin layer of sealer and very slowly insert it to length in the canal.8 The synchronized master gutta-percha cone will carry sufficient material to seal the apex.

Another technique is to place the sealer into the coronal third with a syringe tip and then place some additional sealer on to a glass slab. Take the master cone selected and run it through the sealer (lightly coating the cone) and then introduce this additional sealer into the canal all the way to the apical third. Remove the cone, lightly coat it again with the sealer and slowly insert it all the way to the apical terminus. Either technique will deliver excellent results with multiple fins, grooves and various portals of exit being filled with sealer.

The precise fit of the gutta-percha master cone (in

Bioceramic Sealers Setting Reactions:

The calcium silicates in the powder hydrate to produce calcium silicate hydrate gel and calcium hydroxide. The calcium hydroxide reacts with the phosphate ions to precipitate hydroxyapatite and water. The water continues to react with the calcium silicates to precipitate additional gel-like calcium silicate hydrate. The water supplied through this reaction is an important factor in controlling the hydration rate and the setting time.

For clinical purposes, the advantages of premixed endodontic cement (sealer) should be obvious. In addition to a significant saving of time and convenience, one of the major issues associated with the mixing of any cement, or sealer, is an insufficient and nonhomogenous mix.(3,4) Such a mix may ultimately compromise the benefits associated with the material. Keeping this in mind, bioceramic sealer has been designed as a premixed bioceramic sealer that hardens only when exposed to a moist environment (such as that produced by the dentinal tubules).
combination with a constant taper preparation) creates excellent hydraulics and, for that reason, it is recommended that the practitioner use only a small amount of sealer. However, it is because of the excellent hydraulics and the small particle size, that the sealer flows easily into the fins, grooves and accessory canals. The hydraulics generated are very similar to those created when cementing a custom fabricated post. Furthermore, as with all obturation techniques, it is important to insert the master cone slowly to its final working length. The glass components in the bioceramic sealer bond to the Active GP glass ionomer coated cones as well as to the new bioceramic coated cones. So, in essence, what we have is a bond to the canal wall as a result of the hydroxyapatite that is created during the setting reaction, and we also have a bond between the ceramic particles in the sealer to the ceramic/glass particles in the coated cones.

Future directions of Bioceramic Technology

We can fully expect to see, in the future, the expansion of bioceramic technology into multiple aspects of endodontic treatment. Currently, we see its use in surgical endodontics as well as its use as a sealer in one-cone obturation techniques.

However, we can anticipate the use of bioceramic technology to have multiple variations in obturation, whether as a sealer, as a material to be extruded from a gun-like device and even a bioceramic obturator. Clearly, for bioceramic technology the challenge between its use as an obturator or as a sealer in a one cone obturation technique will only intensify. The good news is that the final decision will be made by you, the clinician. The introduction of a user friendly, room temperature obturation technique that utilizes a constant taper preparation and laser verified gutta-percha, in concert with a new bioceramic sealer (EndoSequence bioceramic sealer), can be used to achieve this goal of an impervious obturation.

References

Tooth Stem Cell Banking-A Review

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Abstract

Stem Cells obtained traditionally were either embryonic in origin or from adult tissue which included both ethical concerns as well as invasive methods. Stem cells derived from teeth are simple to obtain and less invasive. In recent times tooth banks have emerged which will be an easy way to store ones own stem cells. Stem cells can be easily obtained from deciduous teeth and third molars as a result of exfoliation of impacted teeth. These teeth can be stored for treatment of future diseases by using regenerative procedures. In addition, these cells have minimum risk of rejection. Stem cells from younger teeth have better potential for regeneration.

This review will outline the recent trends in stem cells from human teeth and their banking.

Key words: Stem cells, tooth banking, regeneration.

Introduction

Stem cell therapy has been used around the world to treat many medical conditions, and the vast extent of its clinical applications has only been glimpsed so far. The pulp of exfoliated deciduous teeth have been researched extensively and have found to contain chondrocytes, osteoblasts, adipocytes, and mesenchymal stem cells. All of these cell types hold enormous potential for the therapeutic treatment. The application of stem cell therapy using SHED (Stem cells from exfoliated human dentition) to treat these diseases is currently being pursued by many researchers at the institutions around the world. At present there has been clear evidence that primary teeth are a better source for therapeutic stem cells than wisdom teeth, and orthodontically extracted teeth. Primary teeth distal to the canine are generally not recommended for sampling. Primary molars have a broader root base, and therefore, are retained in the mouth for a longer period of time than anterior teeth. In some instances, early removal of deciduous molars for orthodontic considerations (e.g., early intervention for space maintenance) will present an opportunity to recover these teeth for stem cell banking.

Types of Stem Cells in Pulp of Human Teeth—Adipocytes, Chondrocytes, Osteoblasts and Mesenchymal Cells

Adipocytes have successfully been used to repair damage to the heart muscle caused by severe heart attack. There is also preliminary data to indicate they can be used to treat cardiovascular disease, spine and orthopedic conditions, congestive heart failure, Crohn’s disease, and to be used in plastic surgery.

Chondrocytes and Osteoblasts have successfully been used to grow bone and cartilage suitable for transplant. They have also been used to grow intact teeth in animals.

Mesenchymal stem cells have successfully been used to repair spinal cord injury and to restore and movement in paralyzed human patients. Since they can form neuronal clusters, they also have the potential to treat neuronal degenerative disorders such as Alzheimer’s and Parkinson’s diseases.

Tooth Eligibility Criteria for Banking

Not all teeth hold the same regenerative potential. The teeth especially primary incisors and canines with no pathology and at least one third of root left contain these unique types of cells in sufficient number. Primary teeth distal to the canine are generally not recommended for sampling. Primary molars have a broader root base, and therefore, are retained in the mouth for a longer period of time than anterior teeth. In some instances, early removal of deciduous molars for orthodontic considerations (e.g., early intervention for space maintenance) will present an opportunity to recover these teeth for stem cell banking.

Stem Cell Banking- Tooth collection, Stem cell isolation and Storage

Tooth Collection-The tooth exfoliated should have pulp red in color, which is indicative of cell viability. Teeth that become very mobile, either through trauma or disease (e.g., Class III or IV mobility), often have a severed blood supply, and are not candidates for stem cell recovery. The tooth is then transferred into the vial containing a hypotonic solution...
phosphate buffered saline solution, which provides nutrients and prevent the tissue from drying during transport (up to four teeth in the one vial). Placing a tooth into this vial at room temperature induces hypothermia. The vial is then carefully sealed and placed into the thermette a temperature phase change carrier, after which the carrier is then placed into an insulated metal transport vessel. Store-A-Tooth, a company involved in tooth banking uses the Save-A-Tooth device for transporting stem cells from the dental office to the laboratory. The time from harvesting to arrival at the processing storage facility should not exceed 40 hours (15).

**Stem Cell Isolation** - When the tooth bank receives the vial, the following protocol is followed (15).

Tooth surface is cleaned by washing three times with Dulbecco’s Phosphate Buffered Saline without Ca++ and Mg++ (PBSA) after which disinfection is done with disinfection reagent such as povidone iodine and again washed with PBSA. The pulp tissue is isolated from the pulp chamber with a sterile small forceps or dental excavator. Stem cell rich pulp can also be flushed out with salt water from the center of the tooth. Contaminated Pulp tissue is placed in a sterile petri dish which was washed at least thrice with PBSA. The tissue is then digested with collagenase Type I and Dispase for 1 hour at 37°C. After this isolated cells are passed through a 70 μm filter to obtain single cell suspensions. Then the cells are cultured in a Mesenchymal Stem Cell Medium (MSC) medium which consists of alpha modified minimal essential medium with 2mM glutamine and supplemented with 15% fetal bovine serum (FBS), 0.1mM L- ascorbic acid phosphate, 100U/ml penicillin and 100μg/ml streptomycin at 37°C and 5% CO2 in air. Usually isolated colonies are visible after 24 hrs. Different cell lines can be obtained such as odontogenic, adipogenic and neural by making changes in the MSC medium.

**Stem Cell Storage- Cryopreservation and Magnetic freezing.**

Cryopreservation is the process of preserving cells or whole tissues by cooling them to sub-zero temperatures (9). At these freezing temperatures, biological activity is stopped, as are any cellular processes that lead to cell death (16,17). Cells harvested near end of log phase growth are best for cryopreservation. The cells are pre-served in liquid nitrogen vapor at a temperature of less than -150°C. This preserves the cells and maintains their potency. In a vial, 1-2x 10^6 cells in 1.5 ml of freezing medium is optimum. Ice injury is a major concern for tissue cryopreservation. Kawasaki et al. suggested that the slow and rate-controlling freezing reduced the ice injury of cryopreserved living cells. Papaccio G et al (2006) studied the differentiation and morpho-functional properties of cells derived from stem cells after long-term cryopreservation to evaluate their potential for long-term storage with a view to subsequent use in therapy. They concluded that dental pulp stem cells and their osteoblast-derived cells can be long-term cryopreserved and may prove beneficial for clinical applications (20).

The most serious problem during freezing is cell damage induced by ice crystal formation inside the cells as well as mechanical stresses by extracellular ice formation. To prevent cell damage vitrification can be utilised, which freezes cells quickly before ice crystals can form, is an efficient approach used to cryopreserve oocytes and embryos.

Magnetic freezing is the Cell Alive System (CAS). Under the condition of CAS magnetic field energy, water clusters do not accumulate but remain in smaller groups, thus minimizing restraining the expansion of the water. This technology, is called CAS and uses the phenomena that applying even a weak magnetic field to water or cell tissue will lower the freezing point of that body by up to 6-7 degrees Celsius. Once the object is uniformly chilled, the magnetic field is turned off and the object snap freezes. The Hiroshima University company is the first expression of this new technology. Using CAS, Hiroshima University claims that it can increase the cell survival rate in teeth to as high as 83%. This compared to 63% for liquid nitrogen (-196 degrees C), 45% for ultra-cold freezing (-80 degrees C), and just 21.5% for a household freezer (-20 degrees C). Maintaining a CAS system is a lot cheaper than cryogenics and more reliable as well (21).

**Commercial Aspect of Tooth Banking**

These cells can be best utilized for the patients from which they are harvested, and to a certain extent their immediate family and blood relatives. As such, it is inevitable that the key to successful stem cell therapy lies in being able to harvest the cells at the right point of development and to safely store them until accident or disease requires their usage. They can be potentially stored for decades, and the cost and technical difficulty of doing this properly make stem cell therapy using one’s own cells a still uncertain bet. Till date, tooth banking is not very popular but the trend is catching up mainly in the developed countries.

In the USA, BioEden(Austin, Texas), has international laboratories in the UK (serving Europe) and Thailand (serving South East Asia) with further expansion plans for Russia, Australia, India and the Middle East. StemSave (USA) and Store-A-Tooth (USA) are also companies involved in banking tooth stem cells and expanding their horizon in other countries.

In Japan, the first tooth bank was established in Hiroshima University and the company was named as “Three Brackets” (Suri Buraketto) in 2005. Nagoya University (Kyodo, Japan) also came up with a tooth bank in 2007. Taipei Medical University (TMU) in collaboration with Hiroshima University opened the nation’s first tooth bank in September, 2008 with the goal of storing teeth for natural implants and providing a potential alternative source for harvesting and freezing stem cells including SHED (21).
The Norwegian Tooth Bank set up in 2008 is collecting exfoliated primary teeth from 100,000 children in Norway. The Tooth Bank is a sub-project in the Norwegian Mother and Child Cohort Study (MoBa) (22).

Conclusion

Stem cell therapy is emerging as a revolutionary treatment modality to treat diseases and injury, with wide-ranging medical benefits. SHED are stem cells found in the exfoliated deciduous/primary teeth of children. Recent studies show that they appear to have the ability to develop into more types of body tissue than other types of stem cells. This difference opens the door to more therapeutic applications. The existing research has clearly shown that primary teeth are a better source for stem cells. While the promise of the immense scope and magnitude that stem cell therapies will have upon the population will only be fully realized in the future, Dental Professionals have realized that the critical time to act is now. The available opportunities to bank their patients’ dental stem cells will have the greatest future impact if seized while patients are young and healthy.

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Ergonomics and musculoskeletal disorders- A short review

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Abstract

The World Health Organization defines musculoskeletal complaints as disturbing static and dynamics of muscles, tendons, peripheral nerves, vascular system, which is not a direct result of instantaneous events (slip, misstep, etc.). Musculoskeletal pain and fatigue may influence posture control which can increase the risk of errors and may result in low work efficiency. The most common musculoskeletal disorders are caused by prolonged static posture of the dentist, which causes muscle fatigue, ischemia, trigger zones, pain, and protective contractions of muscle, followed by joint hyper mobility, nerve compression, and local degeneration of nerve and of muscle fibres. When referring to the vertebral column, these prolonged incorrect postures may lead to the degeneration of intervertebral discs and the apparition of herniated disc. Finally, these disruptions will cause increased musculoskeletal imbalance, respectively musculoskeletal pain syndrome.

Ergonomics and musculoskeletal disorders

Ergonomics is an applied science concerned with designing and arranging things people use so that the people and things interact most efficiently and safely. “Ergon” means work and “Nomos” means natural laws or systems. (1) OSHA refers to the word “ergonomic” as the relationship of the human/environmental interface that does not produce injury.

Although the causes of any particular case of a Musculoskeletal disorder (MSD) are exceedingly difficult to identify with complete accuracy, certain risk factors are typically discussed in the field of ergonomic studies. The primary occupational risk factors for MSDs discussed in the literature include. (2)

- Repetition
- Force
- Mechanical stresses
- Posture
- Vibration
- Cold temperature
- Extrinsic stress.

National institute of Occupational Safety and Health in its study reported that any repetitions in motion particularly in combination with high force or awkward postures increased the risk of developing musculoskeletal disorders.(3)

For any particular MSD to occur a risk factor may not necessarily be a causation factor. Rather than due to a single risk factor MSD can be a combination of more than one risk factor. In evaluating any particular case of a MSD, that risk factors may be experienced by the affected individual during non-occupational activities.(2) The special character of dental work is connected with and accompanied by onerous and harmful effects. Dentists adopt standing or sitting positions frequently and also twisting of spine, connected with excessive tightening of some tissues and straining of others, could be the source of MSDs.(4) While addressing any ergonomic issue, focussing solely on the workplace would be a mistake. Even though a person who is exposed to all of the risk factors might not develop a MSD. Two people may respond in different ways even though exposed to the same combination of risk factors. A few risk factors are given below. (2)

Repetitions: Repetition rate is defined as the average number of movements or exertions performed by a joint or a body link within a unit of time. These repeated identical motions performed over a period of time could cause over-extension and overuse of certain muscle groups and this could lead to muscular fatigue. Symptoms are often seen in the stabilising or antagonistic tendon and not to the tendon or muscle group involved. Varying the tasks of muscle groups with periods of activity alternated with periods of rest may be beneficial in reducing the possibility of injury.

Force: Force is the mechanical or physical effort to accomplish a specific movement or exertion. For example: using the hands instead of a clamp to hold an object while performing a task such as placing an interproximal composite restoration. The amount of force required by an activity can sometimes be magnified causing even more muscular fatigue. If for example, in the just described dental procedure the arms are also elevated at the time.
Mechanical Stresses: Mechanical stresses are defined as impingement or injury by hard, sharp objects, equipment or instruments when grasping, balancing or manipulating. Such stresses are encountered when we work with forearms or wrists against the edge of a desk or work counter. When pressed into the sharp edge the muscles and tendons are impinged. If our hand is used as a hammer to close a lid securely and especially when it had raised surfaces or sharp edges it creates mechanical stresses.

Posture: Posture is the position of a part of the body relative to an adjacent part as measured by the angle of the joint connecting them. Assuming an extreme posture at or near the normal range of motion is postural stress. Posture is one of the main occupational risk factor. For every articulating body joint there is a neutral zone and the range of motion is defined by movements that do not require high muscular force or cause undue discomfort. The risk of injury increases whenever a person performs tasks outside the neutral range in a deviated posture. For the upper arm and shoulder area neutral posture is relaxed, with the shoulders down and on the same plane, with arms at the side. When one works with the arms abducted away from the body, overextended and shoulders hunched these joints will be placed at the end of their normal range of motion and require higher muscular force and this greatly increases the risk for injury. Sitting in strained positions, such as tilting sideways, twisting the vertebral column, bending forward or slumping begin in response to compensation for specific work relationships and can become habit over time. Torso twist, tipped shoulders, head tilt or rotation, raised elbows (dominant, non-dominant, or both) and operating with hands close to the face are associated with increased risk of musculoskeletal symptoms.

Vibration: Dental handpieces and powered automatic instruments operate at high frequencies in the 5000 to 10,000 Hz range, and duration of exposure to vibratory force during dental procedures is relatively short. So the risk appears to be relatively small in dentistry. The vibratory peaks experienced using dental handpieces is in the frequency range similar to driving a car. However, few non-occupational activities of the practitioner may involve this risk factor. For example, use of a chain saw or powered wood working tools for extended periods of time.

Cold Temperature: Low temperatures reduce manual dexterity and increase the symptoms of nerve-end impairment.

Extrinsic Stress: It may include such variables as job variety, job control, workload, time pressure, and financial constraints. Two individuals exposed to the same combination of risk factors and to the same degree will respond differently. One worker may not experience any discomfort, while another might develop a MSD. The reason is not fully understood. Some predisposing factors like age, rheumatoid arthritis, renal disease, hormonal imbalances, diabetes, and hypothyroidism are biological mechanisms that could account for an increased occurrence of tissue damage and MSDs. Epidemiological evidence is there for other factors like weight, wrist dimension, but the mechanism is less clear. There are a host of non-work risk factors inherent to the hobbies and other activities a person engages in when away from work like knitting, bowling, computer and excessive driving.

TYPES OF MSDs

Back Problems

Lower back pain: Low back pain (LBP) has been, and continues to be a problem among dental personnel. They can either be of individual origin or related to work place such as physical, biomechanical and psychosocial.(5) Reports show that 90% of back pain resolves within 6-12 weeks. The problem most people have is that there is a high rate of recidivism. Between 70% and 90% of people have recurrent episodes of pain, and one third of patients continue to have persistent, recurrent or intermittent pain after their first episode. In addition to the difficulty with healing certain tissue types (such as with spondylolisthesis), the degenerative process is ongoing with age, and many patients do not minimize potential risk factors. All of this can contribute to continued episodes of LBP. The cause of LBP is often multifactorial. Any tissue or structure innervated with afferent nerve fibres has the potential to be a pain generator. That includes muscles, ligaments, facet and sacroiliac joints, intervertebral discs, nerve roots, and bony periosteum. There can be many other biomechanical and functional deficits that might lead to tissue pain. In addition, the degenerative cascade affects multiple areas of the lumbar spine, including potentially, all of the pain generators.(2) Repetitive or static awkward body posture which results from excessive bending and twisting will increase the stress on spine and cause disproportionate loading of its structures.(5)

A fall, sudden jarring, or lifting incident can initiate the onset of pain in all of the tissues previously listed. However, certain persons are at increased risk of injury. Disc herniation occurs more often in middle age, usually due to early effects of degeneration of the outer disc annulus, combined with increased disc swelling pressure of the inner nucleus. It has also been proved that combined motions of lumbar flexion with rotation increase risk to the lumbar disc. This is further exacerbated by inflexibilities around the hips and pelvis, as well as relatively weak stabilizers of the lumbar spine including the abdominal and gluteal muscles. Back pain can exist due to underlying normal age related processes, become exacerbated by abnormal postures, relative weakness and decreased endurance, and then exacerbated by a “specific” injury.

The treatment of low back pain has to be individualized for each patient. There is no one particular mode of treatment but various ones including postural correction, proper patient positioning, exercise and possibly specific physical therapy techniques and/or manipulation may be beneficial.(2)

Upper back pain
This is not as common as lower back pain. The thoracic spine is designed for support in standing and for caging the vital organs, and is quite strong. It rarely experiences symptoms of degeneration as there is little movement and great stability. An injury or trauma from strain could cause pain. Conditions like osteoporosis can predispose one to specific conditions such as compression fractures, although the spinal structures are less commonly injured. A more frequent cause of mid back pain is muscular pain from the postural muscles and scapular muscles. The contributions of abnormal and static postures, poor endurance and strength and overall individual conditioning need to be taken into account. Some rehabilitation efforts, because of the large muscles involved, include strengthening and stretching exercises, which mimic functional activities, and attention to posture.

Hand and Wrist Problems

MSDs of the hand and wrist can occur in different forms such as, cumulative trauma disorder, repetitive strain injury, occupational repetitive micro-trauma, repetitive motion injury, overuse syndrome, carpal tunnel syndrome and repetitive stress disorder. A constant flexion and extension motion of the wrist and fingers is a predominant cause of repetitive motion hand disorders. What seems to be the most detrimental is the Chronic, repetitive movements of the hand and wrist, especially with the hand in “pinch” position. Other common contributing factors to hand and wrist injuries include movements in which the wrist is deviated from neutral posture into an abnormal or awkward position, working for too long a period with no rest or alternation of hand and forearm muscles, mechanical stresses to digital nerves from sustained grasps to sharp edges on instrument handles, forceful work and extended use of vibratory instruments. Some of the specific hand and wrist conditions are:

Tendinitis/Tenosynovitis:

It is the inflammation of the tendon and tendon sheath respectively. Pain occurs during physical movement that places the tendons in tension. Any of the tendons of muscles that control the movement of the fingers, wrist and forearm can be inflamed. The most common types of tenosynovitis of the hand and wrist involves with the muscles of the thumb and index finger.

DeQuervain’s Disease: is an inflammation of the common tendon sheath of two muscles to the thumb – abductor pollicis longus and extensor pollicis brevis. Predisposing activities are postures that maintain the thumb in abduction and extension, forceful gripping, and thumb flexion combined with wrist ulnar deviation. Symptoms include sharp pain and swelling over the radial styloid process of the wrist, the bony prominence just proximal to the wrist joint. The pain can radiate up the forearm or down into the thumb. Muscle weakness and reduced gripping ability with the thumb will result.

Trigger Finger: Tenosynovitis may progress causing a narrowing of the inflamed tendon sheath preventing the smooth movement of the tendon through the digital pulley system. A nodule is formed on the tendon creating a “clicking” or “triggering” movement. Tenosynovitis of the finger is due to sustained, forceful power grip and/or repetitive motion. Symptoms include pain during physical movements that place the tendons in tension and the presence of warmth, swelling and tenderness of the tendon on palpation.

Carpal Tunnel Syndrome: (CTS) Cumulative trauma disorder, repetitive strain injury and repetitive stress disorder are terms often used to describe the condition when the nerves innervating the hands are compressed. Any of the three nerves of the hand – medial, radial, or ulnar can be affected. The most common of these nerve compressions for dentistry, as well as for the general population, is carpal tunnel syndrome. Carpal tunnel syndrome is difficult to deal with in the occupational setting because so many non-work factors may be involved. Studies confirm that patients with work-related carpal tunnel syndrome have a high prevalence of concurrent medical conditions that are capable of causing this syndrome without respect to any particular occupation. These medical factors include hormonal factors like pregnancy, oral contraceptives, hormone replacement, and menopause and genetic predisposition; obesity metabolic or inflammatory diseases like arthritis, diabetes, hypothyroidism, neoplasm, gout, myxedema, Amyloidosis, multiple myeloma. Statistics reveal that CTS is at least three times more common in women than in men. (2)

Typically, carpal tunnel syndrome manifests during middle age. Carpal tunnel syndrome is a peripheral neuropathy caused by compression of the median nerve as it passes through the bony landmark in the wrist known as the carpal tunnel. (6) Tenosynovitis, an inflammation or swelling of the synovium around the tendons, may occur with repetitive, forceful exertion of the fingers, particularly with the wrist in a deviated position. The increased swelling cannot be accommodated in the limited space of the carpal tunnel, resulting in compression of the median nerve and its blood supply. It is either the compression of the median nerve, or the metabolic dysfunction of the median nerve due to obstruction of its vascular supply or both, that results in a variety of symptoms like,(2) • Tingling or numbness in the hand • Shooting pain from the hand up the arm • A swollen feeling in the hand without visible swelling. • Hand weakness and clumsiness of the hands especially in the morning. • Stiffness and numbness in the thumb, index finger, middle finger and radial side of the ring finger • Difficulty grasping and pinching • Frequently dropping objects due to reduced sensation to touch. • Symptoms are worse at night. • Occurs most often in the dominant hand but is frequently bilateral. Carpal tunnel syndrome is accurately diagnosed by
the presence of any two of three criteria:
1) Clinical symptoms 2) physical tests (i.e., Phalen’s test, Tinel’s sign) 3) Electro diagnostic studies 4) determination of vibro tactile perception threshold. (6)

Guyon’s Syndrome: Guyon’s syndrome or ulnar neuropathy most commonly occurs secondary to injury or compression at the elbow as the ulnar nerve passes through the cubital tunnel. In addition, the nerve can also be compressed at the base of the palm as it passes through Guyon’s Canal. (2) A variety of causes of Ulnar nerve compression in Guyon’s canal can be trauma, Lipoma, ganglion cysts or normal anatomic variants such as presence of abductor digiti minimi muscles coursing through the canal or existence of a fibrous arch overlying the deep motor branch of Ulnar nerve.(7)

Compression of the ulnar nerve can occur just proximal to Guyon’s canal or at the distal end where the motor branch of the ulnar nerve enters an arcade of ligaments and tendons. Symptoms of ulnar neuropathy generally include pain, numbness and/or tingling in the distribution of the ulnar nerve in the ring finger and the small finger; and a shooting electrical sensation down the ulnar aspect of the arm. Motor symptoms are less common, but may include loss of control of the small finger, weakness and clumsiness of the hand.

Diagnosis of Guyon’s syndrome is accomplished using clinical symptoms, physical examination and electro-diagnostic studies.(2)

Suggested Interventions for Consideration (2)

Maintaining a healthy, comfortable and productive work environment for the dental team takes an awareness of the ergonomic risk factors. Often, the best intervention is the simplest. Something as simple as choosing alternate instrument grips, body, arm or finger positions, treatment sequencing; or instrumentation techniques can improve the work environment.

Some Interventions of Universal Applicability

According to the International Standards Organization (ISO #6385) there are some core interventions applicable to every workplace:

- Design work to allow machinery to do/assist highly repetitive tasks
- Avoid extreme posture when exerting high force

These general interventions should be considered in any case of an MSD, or even during remodelling or when purchasing new equipment.

Other Interventions for Consideration in the Dental Practice:

In addition to widely recognized general interventions, consider the following interventions as well:

- Exercise caution in purchasing equipment
- Early Treatment of MSDs
- Posture and stools
- Patient positioning
- Hand instruments
- Automatic instruments
- Delivery systems
- Lighting and magnification
- Gloves
- Four-handed dentistry
- Supervised exercise/stretching
- Proper temperatures
- Procedures and administration

Conclusion

The incorrect posture of dentist seems to put them at risk for the occurrence of musculoskeletal disorders. The prevention of these affections imposes the application of ergonomic principles referring to the dentist position during all the dental treatments.

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