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Management of Weakened Anterior Teeth: Intraradicular Rehabilitation: A Review

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Abstract: *This paper highlights the fact that many anterior teeth requiring restoration are severely weakened having wide, flared canal spaces, and thin dentinal walls that are prone to fracture. Traditionally these teeth have been restored using metal posts and are often unsuccessful because of lack of retention or root fracture. This paper describes how mineral trioxide aggregate (MTA) can be used to form an immediate apical seal rather than waiting months for apexification. Weakened roots can be reinforced using dentine bonding agents, composite resin and if insufficient coronal tooth structure is present a quartz fibre post can be placed to retain a composite core.Biological dentin post can also be placed for the management of intraradicular rehabilitation.*
Key words: *Apical seal, Calcium hydroxide, MTA, Intraradicular rehabilitation using bonded composite, Luminox technology, Fibre post, Biological dentin post*

I. Introduction

The functional and esthetic rehabilitation of compromised, root-filled teeth presents a difficult restorative problem for the practicing dentist. Loss of tooth substance in these affected teeth may result in little or no remaining crown structure and weakened, thin-walled roots with widely flared canals.[1]In some cases, development of secondary caries around pre-existing posts may further complicate the matter.

Moreover, some cases may involve trauma to young permanent teeth which have large canal spaces prior to completion of root formation. Other conditions include internal resorption and iatrogenic damage resulting from large access preparations where flared root canals with thin dentinal walls are too weak to withstand normal masticatory forces and are prone to fracture. [2-4]

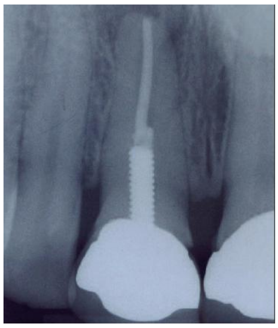
Restoration with cast metal posts can cause wedging forces coronally that may result in irreversible failure because of fracture of an already weakened root.[5-6] The geometry of the flared canal also results in a very wide, tapered and unretentive post.[7]

This paper describes the various alternative techniques that have been successfully implemented for the management of such teeth.

Apical Seal

Teeth that require intraradicular reinforcement are frequently accompanied by a large communication between the root canal and the periodontal ligament. This classically happens, for example, when a large root canal has been over-prepared apically, leading to damage to the apical constriction and loss of an apical stop for conventional obturation.[7]

Tooth 11 has no apical constriction visible radiographically and as such it has not been possible to compact gutta-percha without the risk of pushing the material beyond the radiographic apex of the tooth. As a result the patient's dentist has attempted to use single gutta-percha cone which in adequately obturates the root canal system and has led to a persistent bacterial contamination and chronic periradicular periodontitis.



Periapical radiographs showing upper central incisors of a 14-year-old female patient. These teeth suffered trauma and lost pulp vitality prior to completion of root formation resulting in open root apices and periradicular radiolucencies.

Apical Seal with Calcium Hydroxide

Apexification is defined as a 'method to induce a calcified barrier in a root with an open apex, or the continued apical development of an incomplete root in teeth with necrotic pulp'.[8]

The use of calcium hydroxide was first introduced by Kaiser in 1964 who proposed that this material mixed with camphorated parachlorophenol (CMCP) would induce the formation of a calcified barrier across the apex.[9]

Mitchell and Shankwalker studied the osteogenic potential of calcium hydroxide when implanted into the connective tissue of rats. They concluded that calcium hydroxide had a unique potential to induce formation of heterotopic bone in this situation.[10]

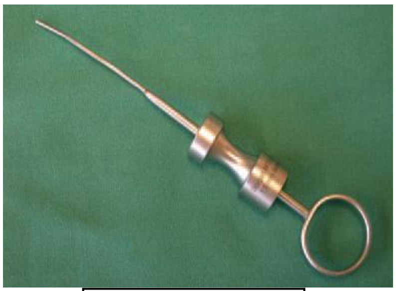
Holland et al. have demonstrated that the reaction of the periapical tissues to calcium hydroxide is similar to that of pulp tissue. Calcium hydroxide produces a multilayered necrosis with subjacent mineralization.[11] Schroder and Granath have postulated that the layer of firm necrosis generates a low-grade irritation of the underlying tissue sufficient to produce a matrix that mineralizes. Calcium is attracted to the area and mineralization of newly formed collagenous matrix is initiated from the calcified foci.[12]It appears that the high pH of calcium hydroxide is an important factor in its ability to induce hard tissue formation.[8]The weakening of dentin after the calcium hydroxide placement for a longer time may be due to the proteolytic capacity of calcium hydroxide. This leads to weakened tooth structure with thin dentinal walls and the remaining tooth structure prone to fracture.[13]

Apical Seal With MTA

There is increasing popularity with one visit apexification technique using Mineral Trioxide Aggregate (MTA) as osteoconductive apical barrier. MTA is relatively non cytotoxic and stimulates cementogenesis. This Portland cement based material generates a highly alkaline aqueous environment by leaching of calcium and hydroxyl ions, rendering it bioactive by forming hydroxyappatite in presence of phosphate containing fluids. Unlike the extended use of Ca(OH)2 in immature roots, prolonged filling of these roots with MTA did not reduce their fracture resistance .[14]

Torabinejad reported the ingredients in MTA as tri calcium silicate, tricalcium aluminate, tricalcium oxide and silicate oxide with some other mineral oxides that were responsible for the chemical and physical properties of aggregate. The powder consists of fine hydrophilic particles that set in the presence of moisture. The hydration of the powder results in a colloidal gel with a pH of 12.5 that will set in approximately 3 hours.[15]It is commercially available as ProRoot MTA (Dentsply Tulsa Dental, Tulsa) and has been advocated for use in the immediate obturation of open root apex. MTA has the ability to induce cementum like hard tissue when used adjacent to the periradicular tissues. MTA is a promising material as a result of its superior sealing property, its ability to set up in the presence of blood and its biocompatibility. Moisture contamination at the apex of tooth before barrier formation is often a problem with other materials used in apexification. As a result of its hydrophilic property, the presence moisture does not affect its sealing ability.[16]

Pro root MTA



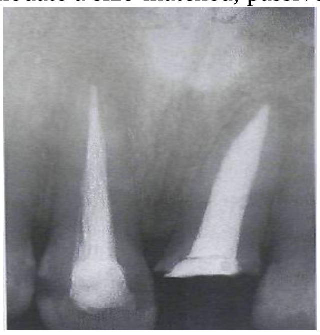
Dovgan carrier

Root Reinforcement

The problem in restoring weakened root is the fact that the remaining root dentin is thin and prone for fracture.[7]

Lui Concept on Root Reinforcement

This technique involved acid etching of the internal radicular dentin in combination with adhesive bonding and lining of the thin canal walls with auto curing resin composite. The bonded resin composite, besides acting as a reinforcing substitute for dentin, also reconstructed a new post canal that could accommodate a size-matched, passive, parallel-sided, well-fitting post.



Paired teeth right central incisor with a normal-sized canal and left central incisor with a flared canal

Flared canal in the maxillary left central incisor reinforced with resin composite

The use of auto curing resin composite can be difficult because the dentist has no control once the rapidly polymerizing resin is placed in the root canal, especially in deep radicular defects. In such situations, the use of light-curing resin composite is preferred because it has better handling characteristics and the on-demand set allows sufficient time and control for proper placement in the root canal. However, light curing resin composite only has a depth of cure of 4 to 5 mm, because of the limited transmission of light through the composite.[1]The introduction of light transmitting plastic posts has subsequently solved this problem and the technique has now been clinically used to reinforce teeth compromised by caries,[3] trauma,[3,17]developmental anomalies,[3] internal résorption,[3,18] iatrogenic causes,[3] and various situations of thin-walled, flared canals.[19,20]

Luminox Weissman Technology

The introduction of transilluminating plastic posts (Luminox Weissman Technology) has enabled the transmission of light into the root canal to polymerize composite resin placed within it. Besides these light-transmitting posts, the system also carries matching smooth plastic impression posts, matching grooved burnout casting posts, matching prefabricated titanium, stainless steel, and gold-plated metal posts, as well as mated reamers and retentive groove cutters. Large deep coronal root defect caused by gross intraradicular extension of caries into a previously traumatized central incisor that had subsequently been endodontically treated.

The apical portion of the obturated root canal is first prepared with suitable reamers to the desired size and depth to fit a corresponding-sized light-transmitting plastic post carrying a depth-marking ring. The matched post is removed and the internal root dentin is acid etched (e.g. Tooth Conditioner Gel, Caulk/Dentsply) rinsed, and dried. To bond the composite resin to dentin, a dentinal bonding system (e.g., Prisma Universal Bond 3, Caulk/Dentsply) is used according to the manufacturer's instructions. The dentinal primer is applied with a brush over the dentinal surfaces and dried with oil-free air. The adhesive is then similarly applied over the primed dentin. After the light-transmitting post is reinserted, the adhesive is cured for 10 seconds with a suitable light-curing unit. The light-transmitting post is again removed.

For reconstituting and rehabilitating the root, a visible light-curing hybrid composite resin (e.g., Prisma AP, H, Caulk/ Dentsply) is selected, to facilitate its placement into the depths of the root canal, the predosed material in the short-nozzle compules can be transferred to a longer-nozzle centrix tube. After the plug is inserted and the nozzle is placed into the syringe barrel, the composite resin is dispensed into the bonded canal. Suitable plastic instruments are used to pack the composite resin into the canal. The light transmitting post is reseated to its full depth to ensure the desired post canal length is achieved and, at the same time, through the pressure exerted, to facilitate good adaptation of the composite resin against the canal walls.

Following removal of excess material from the coronal root face, a light-curing unit is applied to the end of the plastic post to transilluminate light along its entire length to polymerize the surrounding composite resin. The post is then removed with a hemostat, leaving a reinforced root with a patent, size matched post canal .With the root now rehabilitated, several options are available for restoration of the damaged to orhto function and esthetic.Should a casting be desired, an antirotational cavity can be prepared on the root face, and matching plastic or prefabricated metal posts can be used with either the direct or indirect technique to obtain the post and core. Alternatively, a mated prefabricated grooved metal post (Dentatus Classic, Weissman Technology) can be cemented into the prepared canal and a composite resin core can be built up.[3]

A coronal defect at the left central incisor is caused by carious extension into previously traumatized and immature teeth

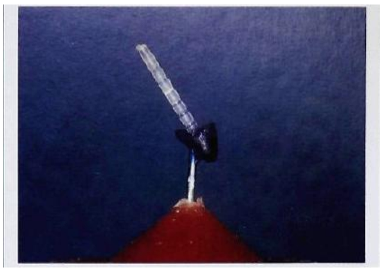
A matched light-transmitting plastic post is fitted into a pre- into the prepared root canal of the central incisor,

A longer-nozzle centrix tube is used to facilitate placement of composite resin into the bonded root canal

Light is transmitted into the root canal using light transrnitting plastic post to polymerize the intra canal composite resin.

A matching post canal is created in conjunction with composite resin reinforcement of the defective

An anti rotational cavity is prepared in the composite resin reinforcement at the root face.



A core wax-up is formed on a matching grooved Plastic burnout casting post.

Prefabricated matching grooved metal post is cemented into the reconstituted post canal.

A composite resin core is built up and secured onto the cross out head of the prefabricated cemented post.

The reinforced central incisor is finally restored to aesthetics and function with a porcelain bonded crown.

Fibre Reinforcement Composite Post

Recently, application of fiber-reinforced composite (FRC) posts in endodontically treated teeth has increased in popularity because of their suggested favorable biomechanical properties, esthetic appeal, easy removal for endodontic retreatment, and single visit placement[21-23].Based on theoretical considerations and finite element analyses, FRC posts are more flexible than cast metal posts and allow better distribution of forces, resulting in fewer root fractures.[21,24] Clinical studies have reported a success rate of 95% to 99% for teeth restored with FRC posts, with no occurrence of root fracture during the study periods.[25,26]

Root Reinforcement Using Biological Post

"Biological Post" serves as a homologous recipe for intraradicular rehabilitation of a fractured endodontically treated tooth by virtue of its biomimetic property.[27]

Fabrication of Biological Post

A freshly extracted, intact maxillary tooth is chosen and subjected to autoclaving at 121deg C for 15 minutes. The tooth is then sectioned bucco-lingually along the long axis using a diamond disk. The direct wax impression of the prepared post space served as a guide for the shape, thickness and length of the post. Using the wax impression, further contouring of the sectioned tooth into a dentin post and core is done. Space throughout the process of contouring. Following satisfactory adaptation of the biological post clinically and radiographically, the post is cemented in the root canal using Self-Adhesive Resin Cement (3M ESPE) following the manufacturer instructions.[27]

II. Summary

In summary, Apical sealing of tooth plays an important role for the intraradicular rehabilitation. MTA is preferred over calcium hydroxide for the apical sealing because of its biological, mechanical and chemical properties. This paper describes a technique that incorporates the advantage of MTA as an apical barrier and internal rehabilitation of the root canal with using various posts. A quartz fibre post subsequently bonded in place allows the retention of a composite core, if required and allows continued use of adhesive and aesthetic technology. In recent study teeth restored with solid dentin posts exhibited higher fracture resistance than those restored with FRC posts.

This can probably be explained on the basis of the following factors:

• Physiomechanical properties of a dentin post
• Uniform stress distribution
• Shock-absorbing potential of a dentin post.[28]

III. Conclusion

Endodontic treatment has progressed significantly over the last two decades leading to greater knowledge, clinical success and comitant cost of endodontic treatment. Failure in teeth that have been root canal treated is more likely to be the result of failure of the restoration that has been placed rather than endodontic treatment itself. This paper describes how compromised roots, whether as a result of a non vital immature root ,secondary caries around an existing post or overzealous, inappropriate tooth preparation ,can be reinforced thus maintaining a functional unit within a arch.

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