

## RESTORATION OF ENDODONTICALLY TREATED TEETH WITH DIFFERENT CROWNS: A COMPARATIVE STUDY

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### Abstract

The optimal way to restore teeth after endodontic treatment continues to remain a controversial topic of heated debate to this day. Endodontically treated teeth (ETT) present with significantly different mechanical properties compared to vital teeth. The modifications in the biomechanical properties and structural integrity of the teeth are most-likely attributed to the volumetric loss of the hard tissues, extent of carious lesion, fracture propagation, final cavity preparation in addition to the access cavity prior to endodontic therapy.

Hence based on above findings the present study was planned for comparative evaluation of Restoration of Endodontically Treated Teeth with Different Crowns.

The study was planned in Department of Dentistry, Anugrah Narayan Magadh Medical College and Hospital, Gaya, Bihar. The 60 cases of the Endodontically treated teeth (ETT) were enrolled in the present study. The patients were divided in the 4 groups as per different material and restorations given.

The survival of ETT is contingent on the residual sound tooth structure that remains after the endodontic access and caries removal are performed consequently the most important factors upon restoring ETT become the maximum preservation and conservation of enamel, dentin and the dentinoenamel junction. Hence, bonded partial restorations are always preferred over full coverage cementable crowns. More clinical studies comparing adhesive crowns bonded to postless build-ups or post and -core build-ups are needed for a better understanding of postless approaches in biomimetic restorative dentistry.

**Keywords:** Endodontically treated teeth, Crown, cores, post, etc.

### Introduction:

Endodontics is the dental specialty concerned with the study and treatment of the dental pulp.[1] Endodontics encompasses the study (practice) of the basic and clinical sciences of normal dental pulp, the etiology, diagnosis, prevention, and treatment of diseases and injuries of the dental pulp along with associated periradicular conditions. Endodontics has evolved tremendously in the past decade and its applications have immensely improved the quality of dental treatment.

In clinical terms, endodontics involves either preserving part, or all of the dental pulp in health, or removing all of the pulp in irreversible disease. This includes teeth with irreversibly inflamed and infected pulpal tissue. Not only does endodontics involve treatment when a dental pulp is present, but also

includes preserving teeth which have failed to respond to non-surgical endodontic treatment, or for teeth that have developed new lesions, e.g., when root canal re-treatment is required, or periradicular surgery.[2]

Endodontic treatment is one of the most common procedures. If the dental pulp (containing nerves, arterioles, venules, lymphatic tissue, and fibrous tissue) becomes diseased or injured, endodontic treatment is required to save the tooth.

The main purpose of root canal therapy is to remove the diseased pulp, clean and shape the root canal system, disinfect the contaminated root canals, and then obturate (fill) the root canal system to prevent re-infection and promote periradicular healing. The aim is to have radiographic evidence of healing, with no postoperative lesions present, and restored

periradicular health if preoperative lesions were present. The main reason for dental pulpal problems has been related to bacterial contamination of the root canals. Therefore, significantly reducing the bacterial load within the root canal system, and then filling the canals with an inert obturating material aid in preventing bacterial re-infection.[3]

Root canal therapy is not only performed when pain relief from an infected or inflamed pulp is required. It is also done to prevent adverse signs and symptoms from the surrounding sequelae and promote the healing and repair of the surrounding periradicular tissues. An example of which is if there is trauma to a front tooth which has caused it to be avulsed from the bony socket; endodontic treatment is required following re-implantation to preserve the aesthetics and function of the tooth, even though there may be no adverse symptoms of the dental pulp, or pain present at the time.[4][5]

A apicoectomy, also called root end surgery is an endodontic surgical procedure whereby a tooth's root tip is removed and a root end cavity is prepared and filled with a biocompatible material. Microsurgical endodontics—dental surgery using a microscope—may be performed. An apicoectomy is necessary when conventional root canal therapy has failed and a re-treatment was already unsuccessful or is not advised.[6] State-of-the-art procedures make use of microsurgical techniques, such as a dental operating microscope, micro instruments, ultrasonic preparation tips and calcium-silicate based filling materials.

Other endodontic surgeries include dividing a tooth in half, repairing an injured root, or removing roots.[7]

Microsurgical endodontics, the use of magnification devices such as microscopes, and dental loupes, has been widely accepted among endodontists and practitioners; its use is believed to increase accuracy and visualization in the operating field. However, a Cochrane review in 2015 found no evidence to determine whether there's a difference in the outcome of a procedure done by magnification devices or a conventional procedure done with no magnification. The American Association of Endodontics strongly encourages its members to pursue the use of an oral microscope to ensure the highest level of excellence.[8]

Root canal treatment (also known as endodontic therapy, endodontic treatment, or root canal therapy) is a treatment sequence for the infected pulp of a tooth which results in the elimination of infection and the protection of the decontaminated tooth from future microbial invasion. Root canals, and their associated pulp chamber, are the physical hollows within a tooth that are naturally inhabited by nerve tissue, blood vessels and other cellular entities. Together, these items constitute the dental pulp.[9]

Endodontic therapy involves the removal of these structures, the subsequent shaping, cleaning, and decontamination of the hollows with small files and irrigating solutions, and the obturation (filling) of the decontaminated canals. Filling of the cleaned and decontaminated canals is done with an inert filling such as gutta-percha and typically a Zinc oxide eugenol-based cement. Epoxy resin is employed to bind gutta-percha in some root canal procedures. Endodontics includes both primary and secondary endodontic treatments as well as periradicular surgery which is generally used for teeth that still have potential for salvage.[10]

Before endodontic therapy is carried out, a correct diagnosis of the dental pulp and the surrounding periapical tissues is required. This allows the endodontist to choose the most appropriate treatment option, allowing preservation and longevity of the tooth and surrounding tissues. Treatment options for an irreversibly inflamed pulp (irreversible pulpitis) include either extraction of the tooth or removal of the pulp.

Removing the infected/inflamed pulpal tissue enables the endodontist to help preserve the longevity and function of the tooth. The treatment option chosen involves taking into account the expected prognosis of the tooth, as well as the patient's wishes. A full history is required (which includes the patient's symptoms and medical history), along with a clinical examination (both inside and outside the mouth), and the use of diagnostic tests. [11]

The standard filling material is gutta-percha, a natural polymer prepared from latex from the percha tree (*Palaquium gutta*). The standard endodontic technique involves inserting a gutta-percha cone (a "point") into the cleaned-out root canal along with a sealing cement. [12] Another technique uses melted or heat-softened gutta-percha which is then injected or pressed into the root canal passage(s). However,

since gutta-percha shrinks as it cools, thermal techniques can be unreliable and sometimes a combination of techniques is used. Gutta-percha is radiopaque, allowing verification afterwards that the root canal passages have been completely filled and are without voids.

An alternative filling material was invented in the early 1950s by Angelo Sargenti. Filling material has undergone several formulations over the years (N2, N2 Universal, RC-2B, RC-2B White), but all contain paraformaldehyde. The paraformaldehyde, when placed into the root canal, forms formaldehyde, which penetrates and sterilizes the passage. The formaldehyde is then theoretically transformed into harmless water and carbon dioxide. According to some research, the outcome of this method is better than a root canal procedure performed with gutta-percha. There is, however, a lack of indisputable scientific studies according to the Swedish Council on Health Technology Assessment.

In rare cases, the paste, like any other material, can be forced past the root tip into the surrounding bone. If this happens, the formaldehyde will immediately be transformed into a harmless substance. Blood normally contains 2 mg formaldehyde per liter and the body regulates this in seconds. The rest of an overfill will be gradually absorbed and the end result is normally good. In 1991, the ADA Council on Dental Therapeutics resolved that the treatment was "not recommended", and it is not taught in American dental schools. Scientific evidence in endodontic therapy was, and still is lacking. Despite this lack of support, the Sargenti technique has advocates who believe N2 to be less expensive and at least as safe as gutta-percha.[13]

Pain control can be difficult to achieve at times because of anesthetic inactivation by the acidity of the abscess around the tooth apex. Sometimes the abscess can be drained, antibiotics prescribed, and the procedure reattempted when inflammation has been mitigated. The tooth can also be unroofed to allow drainage and help relieve pressure.

A root canal treated tooth may be eased from the occlusion as a measure to prevent tooth fracture prior to the cementation of a crown or similar restoration. Sometimes the dentist performs preliminary treatment of the tooth by removing all of the infected pulp of the tooth and applying a dressing and temporary filling to the tooth. This is called a

pulpectomy. The dentist may also remove just the coronal portion of the dental pulp, which contains 90% of the nerve tissue, and leave intact the pulp in the canals. This procedure, called a "pulpotomy", tends to essentially eliminate all the pain. A pulpotomy may be a relatively definitive treatment for infected primary teeth. The pulpectomy and pulpotomy procedures aim to eliminate pain until the follow-up visit for finishing the root canal procedure. Further occurrences of pain could indicate the presence of continuing infection or retention of vital nerve tissue.

Some dentists may decide to temporarily fill the canal with calcium hydroxide paste in order to thoroughly sterilize the site. This strong base is left in place for a week or more to disinfect and reduce inflammation in surrounding tissue, requiring the patient to return for a second or third visit to complete the procedure. There appears to be no benefit from this multi-visit option, however, and single-visit procedures actually show better (though not statistically significant) patient outcomes than multi-visit ones. [14]

Long term success of an endodontically treated tooth depends on the integrity and durability of the postendodontic material used. Fracture resistance of endodontically treated teeth is less as compared to vital teeth and are more prone to fracture under occlusal load because of changes in strength and modulus of elasticity. Therefore, intracoronary strengthening of teeth may be necessary to prevent fracture, particularly in posterior teeth in which stresses generated by occlusal forces can lead to fracture of unprotected cusp. The prognosis of final coronal restoration depends on type of core reconstruction and the material used. Nowadays, many resin composites specifically designed for core build-up are available with increased filler content for higher strength and to enhance easy manipulation. These materials differ from each other with regard to the amount and type of filler, viscosity, curing mode and build up technique and their physical properties were investigated in various aspects. Introduction of nano-particles as filler has allowed improvements in the filler loads reaching nearly 80% in contemporary composites. They provide improved compressive and flexural strength and thus are being used as posterior restorative composites. Dual-cure composites have been developed as core build-up materials that help in overcoming the limitations of extended chair-side

time, reduced inter-layer strength, increased inter-facial porosity and depth of cure.

The optimal way to restore teeth after endodontic treatment continues to remain a controversial topic of heated debate to this day. Endodontically treated teeth (ETT) present with significantly different mechanical properties compared to vital teeth. The modifications in the biomechanical properties and structural integrity of the teeth are most-likely attributed to the volumetric loss of the hard tissues, extent of carious lesion, fracture propagation, final cavity preparation in addition to the access cavity prior to endodontic therapy.

Hence based on above findings the present study was planned for comparative evaluation of Restoration of Endodontically Treated Teeth with Different Crowns.

#### Methodology:

The study was planned in Department of Dentistry, Anugrah Narayan Magadh Medical College and Hospital, Gaya, Bihar. The 60 cases of the Endodontically treated teeth (ETT) restored with reinforced GFPs (Relaxy Fiber Post, 3M ESPE, Germany), and composite resin cores (Tertic-N-Ceramic, Ivoclar Vivadent, Lichenestine) enrolled in the present study. The quality of ETT should be RCT with no evidence of periapical pathology or root fracture. The periodontium was healthy with no bleeding on probing or bone loss. The patients were divided in the 4 groups as per different material and restorations given.

All the patients were informed consents. The aim and the objective of the present study were conveyed to

them. Approval of the institutional ethical committee was taken prior to conduct of this study.

- Group A: consists of 15 ETT cases with GFP and composite restoration.
- Group B: consists of 15 ETT cases with GFP and porcelain VITA VM (R) 9 (Vita Zahnfabric /Germany) fused to metal restoration.
- Group C: consists of 15 ETT cases with GFP and e. max all ceramic (IPS e.max, Ivoclar/Vivadent) crowns.
- Group D: consists of 15 ETT cases with GFP and zirconia crowns, which consisted of a core's build up with Vita In-Ceram YZ Disc (Vita Zahnfabric/ Germany), and the porcelain build-up were done with porcelain VITA VM(R)9 (Vita Zahnfabric/Germany) crowns.

All the cases after cementation were evaluated both clinically and radiographically after a period of 1week,3 months and 6 months.

#### Results & Discussion:

The restorative approach regarding ETT has changed in recent years. The availability of proven and reliable adhesive dental techniques has expanded the restorative options for the clinician. Amalgam cores and cast metal posts are being replaced by direct composite and glass-fiber posts, in addition to all ceramic and composite resin crowns being often chosen because of their superior aesthetic outcome. [15-16 Furthermore, restorations techniques without the use of post-and-core build-ups are gaining in popularity due to their minimal invasiveness and simplification of clinical steps.

**Table 1:** The Clinical Results of ETT at the Different Time Follow-Up

Clinical Results	One Week	3 Months	6 Months
<b>Movement of the crown margin under finger pressure:</b>			
Group A : Composite	15	15	15
Group B: PFM	15	15	15
Group C : e max	15	15	15
Group D: Zirconia	15	15	15
<b>Fracture of the crown:</b>			
Group A : Composite	15	15	15
Group B: PFM	15	15	15
Group C : e max	15	15	15
Group D: Zirconia	15	15	15
<b>Loss retention of the crown:</b>			
Group A : Composite	15	15	15
Group B: PFM	15	15	15
Group C : e max	15	15	15

<b>Group D: Zirconia</b>	15	15	15
<b>Bonding at post-core/tooth interfaces:</b>			
<b>Group A : Composite</b>	15	15	15
<b>Group B: PFM</b>	15	15	15
<b>Group C : e max</b>	15	15	15
<b>Group D: Zirconia</b>	15	15	15
<b>Periodontal status/ violation of biological Width</b>			
<b>Group A : Composite</b>	15	15	15
<b>Group B: PFM</b>	15	15	15
<b>Group C : e max</b>	15	15	15
<b>Group D: Zirconia</b>	15	15	15
<b>Aesthetic (color changes):</b>			
<b>Group A : Composite</b>	15	15	15
<b>Group B: PFM</b>	15	15	15
<b>Group C : e max</b>	15	15	15
<b>Group D: Zirconia</b>	15	15	15
<b>Recurrent caries at crown margin:</b>			
<b>Group A : Composite</b>	15	15	15
<b>Group B: PFM</b>	15	15	15
<b>Group C : e max</b>	15	15	15
<b>Group D: Zirconia</b>	15	15	15

**Table 2:** Radiographic Results of ETT at the Different Time Follow-Up

<b>Clinical Results</b>	<b>One Week</b>	<b>3 Months</b>	<b>6 Months</b>
<b>Caries at cervical margin:</b>			
<b>Group A : Composite</b>	15	15	15
<b>Group B: PFM</b>	15	15	15
<b>Group C : e max</b>	15	15	15
<b>Group D: Zirconia</b>	15	15	15
<b>Presence of periapical infection:</b>			
<b>Group A : Composite</b>	15	15	15
<b>Group B: PFM</b>	15	15	15
<b>Group C : e max</b>	15	15	15
<b>Group D: Zirconia</b>	15	15	15
<b>Post fracture / root fracture:</b>			
<b>Group A : Composite</b>	15	15	15
<b>Group B: PFM</b>	15	15	15
<b>Group C : e max</b>	15	15	15
<b>Group D: Zirconia</b>	15	15	15
<b>Loss of retention of post:</b>			
<b>Group A : Composite</b>	15	15	15
<b>Group B: PFM</b>	15	15	15
<b>Group C : e max</b>	15	15	15
<b>Group D: Zirconia</b>	15	15	12
<b>Post adaptation in root canal:</b>			
<b>Group A : Composite</b>	15	15	15
<b>Group B: PFM</b>	15	15	15
<b>Group C : e max</b>	15	15	15
<b>Group D: Zirconia</b>	15	15	15

It is previously established that the use of a post may cause a catastrophic failure of the tooth, no matter the type of material. As they are associated with additional removal of sound tissue for post preparation, some studies have been focus on the

alternative postless treatment of ETT. A postless alternative to treat ETT includes the use of the pulp chamber as an extension of crown itself, the so-called endocrown. This technique consists in combining the crown and core build-up in a single element or

“monobloc”. The endocrown requires a simpler and less invasive preparation compared to the multi-step approach of the post-and-core build-up with crown preparation, resulting in decreased treatment time and costs. [17-18]

Nowadays, endocrowns are even obtained in a single appointment using chairside computer-aided design/computer-aided manufacturing (CAD/CAM) technology. As they gained popularity, many researchers and clinicians have published highly successful cases describing the clinical steps for the fabrication of endocrowns. A finite element study concluded the endocrown to be a conservative, predictable and clinically feasible restorative approach for endodontically treated maxillary premolars.<sup>84</sup> According to short-term clinical reports, the survival rate of the endocrowns was 90-95% in posterior teeth. A recent meta-analysis evaluated studies on endocrowns and concluded they perform similarly or better than conventional treatments using intraradicular posts, direct composite resin or inlay/onlay restorations. This technique represents a promising and conservative alternative to full crowns for the treatment of posterior nonvital teeth that require long-term protection and stability. There are few studies using endocrowns for the anterior dentition, including a few finite element analyses and one in vitro study. Ramírez-Sebastià et al [19] found that the use of endocrowns with adhesive material is sufficient for the restoration of endodontically treated incisors with 2 mm of ferrule. Anterior endocrowns have not yet been tested in clinical trials. For posterior teeth, a recent clinical study conducted by Belleflamme et al. [20] evaluated 99 endocrowns made of lithium disilicate or polymer-infiltrated ceramic with a success rate of 99.0% and 89.9% respectively for a mean period of 44.7 months. The authors concluded that, when the adhesive technique is properly applied, endocrowns constitute a reliable approach to restore severely damaged molars and premolars, even in the presence of extensive coronal tissue loss or occlusal risk factors, such as bruxism or unfavorable occlusal relationships. No-post approaches such as endocrowns or postless build-ups-and-crowns are only possible with the application of optimal and reliable adhesion. A very important factor to consider when relying mainly on the adhesive approach is the quality of the adhesion between the restoration and the underlying tooth structure. The adhesion to dentin is considered

weaker than adhesion to enamel and when restoring ETT, most of the interface is in dentin. A proven strategy to increase the dentin bond strength of indirect restorations is by using the immediate dentin sealing (IDS) technique. The studies on postless approaches showing high success rates and outcomes discussed in this review all used IDS in their protocol to optimize bond strength to dentin. Other studies revealed lower success rates using postless build-ups. Those results may be explained by the fact that neither IDS technique or bonded restorations were used, but rather cemented PFM crowns to build-ups with different adhesive approaches.

The survival and success of ETT is significantly influenced by the choice of appropriate restorations. Many studies have reported full cuspal coverage to be the treatment of choice for posterior ETT. The rationale behind providing full-coverage crowns is the protection of ETT from potential future cracks and fractures. This is due to the reduced structural integrity and stiffness associated with the loss of tooth structure in ETT.[21] However, recently, few studies in the literature have reported good longevity for posterior ETT when restored with direct intracoronal restorations without the provision of cuspal coverage, specifically for teeth with limited amounts of structural loss.[22-23] Therefore, using a full-coverage crown where it could have been avoided might be considered an unnecessary removal of valuable tooth structure which could have been otherwise preserved.[24]

A recent systematic review has found insufficient evidence to compare full cuspal-coverage restorations to direct restorations when used for restoring ETT and suggested that the clinicians should make their clinical decisions based on their own clinical experience.[25] In order to assist the clinicians in the decision-making process, decision flowcharts based on prosthodontic principles for restoring ETT were suggested previously.[26] Although such flowcharts were considered helpful by many clinicians, they do not fulfill the modern requirements of conservative adhesive dentistry and do not include the adhesive restorative options currently available. More recently, an online tool has been developed to facilitate access to summaries of the available evidence to help dentists in decision-making regarding the need for cuspal coverage or intracoronal restorations.[27] However, this tool still did not incorporate a guide to aid in choosing

between mechanically retained and adhesive restorations.

There are different materials available for adhesive overlays, such as gold, composite resin, and ceramic materials. The adhesive gold overlays are minimally invasive indirect restorations, which offer the advantage of being biologically conservative of the tooth tissue.[27] The gold overlays were reported to have 89% survival rate over 5 years.[28] However, patients might object to the metal color, especially if the tooth lies in the esthetic zone of the patient.

The indirect resin composite overlay offers a biologically conservative and esthetic option. However, its clinical performance in the posterior dentition is still questionable.[29] A failure rate of 21% over 3 years was reported when used in posterior teeth in parafunctional patients.[30] However, more recent studies are reporting more favorable results.[31-33] The choice between a direct or indirect composite resin restoration can be affected by various factors such as the size of the restoration, cost, number of visits, number of restorations, and the operator's skill in building large composite resin restorations.[34] However, both treatment options were shown to perform similarly in a 5-year randomized controlled trial.[32]

Indirect ceramic restorations are considered an excellent restorative option for patients with high esthetic demands.[35] Compared to a conventional full-coverage crown, the indirect ceramic overlays preserve significant amounts of tooth structure.[7] Short- and long-term data for different ceramic materials used for adhesive overlays have reported excellent results as cusp-replacing restorations.[36-39] An etchable ceramic is used for adhesive ceramic overlays, and most commonly, the second generation of lithium disilicate ceramics (IPS e.max press, Ivoclar Vivadent, Schaan, Lichtenstein, Germany) is selected. It presents improved esthetic and physical properties compared to its predecessors.[40]

### Conclusion:

The survival of ETT is contingent on the residual sound tooth structure that remains after the endodontic access and caries removal are performed consequently the most important factors upon restoring ETT become the maximum preservation and conservation of enamel, dentin and the dentinoenamel junction. Hence, bonded partial

restorations are always preferred over full coverage cementable crowns. More clinical studies comparing adhesive crowns bonded to postless build-ups or post and -core build-ups are needed for a better understanding of postless approaches in biomimetic restorative dentistry.

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