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CAST POST A DIMINISHING LEGACY – REVIEW

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ABSTRACT In modern dental practice, the conservative approach to treating severely carious teeth has largely replaced extraction with endodontic therapy, allowing these teeth to serve as long-term functional components. Advances in restorative techniques have shifted from anecdotal methods to evidence-based practices, emphasizing the importance of proper post-endodontic restoration. The strength of pulpless teeth, altered by endodontic treatment, can be significantly enhanced through strategic restoration. Criteria for selecting appropriate materials and techniques include the amount of remaining tooth structure, anatomical considerations, and functional demands. Custom-cast posts, historically favored for their adaptability, are now often supplemented by fiber posts due to their ease of use and effective performance. Restoration procedures must carefully address the risks of post dislodgment and root fractures, with meticulous attention to cleaning, fitting, and cementation. Success in restoring endodontically treated teeth relies on preserving as much healthy dentin as possible and using well-fitting, durable restorations.

KEYWORDS : Cast post, Restorative techniques, Cementation, Forces

INTRODUCTION

In the past, extraction was often the preferred treatment for severely carious teeth. However, modern dental practice has shifted towards a more conservative approach. The significant success of endodontic therapy has enabled the restoration of such teeth, allowing them to function effectively as long-term components of the oral cavity. The methodologies and guidelines for restoring endodontically treated teeth have progressed from clinical tradition and anecdotal evidence to more structured and evidence-based practices. The objectives of prosthodontics and restorative dentistry are to replace lost tooth structure, maintain function and aesthetics, and protect against fractures and infections. Endodontic treatment involves the removal of the vital tissue from the tooth's canal, leaving it pulpless. This results in a tooth with calcified tissues and markedly less moisture compared to vital teeth. Such changes were once believed to significantly weaken the tooth structure, making it more prone to fractures under masticatory forces.

Contemporary treatment concepts are based on multiple factors to strategically enhance the strength of pulpless teeth. This approach aims to restore and reinforce the tooth so it can withstand both vertical and lateral forces. Franklin Weine has noted that many failures of endodontically treated teeth are due to inadequate post-endodontic restorations rather than the primary endodontic treatment itself. The selection of post-endodontic materials depends on the remaining tooth structure, esthetic requirements, and existing periodontal conditions.

Fiber posts are increasingly favored over metal posts due to their ease of use, reduced time requirements, and supporting clinical and laboratory evidence. Traditionally, custom cast post-and-core systems with metal-ceramic crowns were the preferred treatment. Custom cast posts offer the advantage of conforming closely to the canal's morphology. They remain a better choice in situations requiring changes in core angulation or where there is substantial loss of tooth structure.

Criteria For Selection

A precise treatment plan for endodontically treated teeth must account for their differences compared to intact vital teeth. Restoring these teeth often requires specialized techniques due to the significant loss of tooth structure[5]. The choice of materials and techniques for restoration is influenced by several factors that arise from root canal therapy, including:

- The amount of remaining tooth structure
- Physical changes in the tooth structure
- The anatomical position of the tooth
- The occlusal forces on the tooth
- The restorative needs of the tooth
- The esthetic requirements of the tooth

Amount of Remaining Tooth Structure

The amount of remaining tooth structure is crucial in planning the restoration of endodontically treated teeth. The extent of structure loss can range from minimal due to endodontic access preparation to extensive damage that threatens the tooth's longevity[22,23,24]. The remaining healthy coronal tooth structure is more critical for the long-term success of the restoration than any other factor, as no restorative material can fully replace intact dentin. Access opening during endodontic procedures removes the roof of the pulp chamber, which originally provided structural integrity and flexibility. Studies show that endodontic procedures reduce tooth stiffness by only 5%, primarily due to the access opening, while a mesio-occlusodistal (MOD) preparation can reduce stiffness by up to 60%.

Physical Changes in Tooth Structure

Endodontic treatment leads to irreversible changes in dentin properties. Collagen crosslinking alterations and dentin dehydration result in a 14% reduction in strength and toughness in treated molars[26].

Nature of Dentin Toughness

Dentin is a hydrated, mineralized hard tissue that constitutes most of a tooth. Mature dentin is a composite material consisting of about 30% organic content, primarily collagen, 60% inorganic material, and 10% water. Maintaining an optimal balance between stiffness and dynamic toughness is essential for the mechanical stability of dentin.

Role of moisture

Water interacts with the dentin matrix in a specific manner. In hydrated dentin, water functions as a plasticizer, keeping the matrix soft and flexible. Dentin collagen fibrils are composed of smaller microfibrils separated by water-filled spaces. When dentin becomes dehydrated, these interfibrillar spaces are lost, leading to a reduction in the diameter of the fibrils.

Dentin exhibits visco-elastic properties, which include:

- An increase in strain over time under constant stress (creep)
- A decrease in stress over time under constant strain (stress relaxation)
- Stiffness that varies with the rate of load application

- Frictional resistance during rolling
- Compromise of all visco-elastic characteristics due to the loss of free water

Tooth Position And Occlusal Forces

Considerations For Anterior Teeth

Anterior teeth are primarily subjected to flexural and tensile forces rather than vertical compressive forces. These forces are predominantly applied to the facial and lingual surfaces. Consequently, incorporating an internal post typically does not prevent fractures in these teeth. Since anterior teeth are located away from the fulcrum line, they experience less force compared to posterior teeth. Research by Sorensen and Martinoff indicates no significant difference in the success rates of anterior pulpless teeth with or without crowns[25,26]. Conversely, Lovdahl and Nicholls found that intact endodontically treated central incisors are three times more resistant to fractures than those restored with dowel cores. For discolored endodontically treated teeth, bleaching is often preferred over full crowns to avoid additional loss of tooth structure that would result from crown placement.

Considerations for Posterior Teeth

Posterior teeth naturally have grooves that divide the occlusal surface, and they are subjected to compressive forces that tend to separate the cusps. Therefore, the minimum recommended restoration for an endodontically treated posterior tooth is an MOD onlay. A full crown is generally necessary for posterior teeth as it encircles the tooth, providing support against masticatory forces, particularly for maxillary premolars which are prone to wedging forces and cuspal deflection. Full coverage restorations are usually indicated for posterior teeth unless the tooth has a very conservative occlusal access opening and is not exposed to heavy occlusal stress, such as in a mandibular premolar with a narrow occlusal table and minimal masticatory forces.

Custom-Cast Post & Core

Custom-cast metal posts have long been considered a standard due to their successful clinical history, demonstrating a high success rate. They address the challenge of bonding between the post and core effectively.

Indications for Cast Post and Core

Prefabricated posts, often round in shape, lack the capacity to resist rotational forces[12,26]. When the remaining coronal tooth structure supporting an artificial crown is minimal, a post that can resist rotation becomes crucial. Cast post and core systems are custom-fitted to the prepared root canal space and designed to withstand torsional forces. With the loss of tooth structure from both esthetic veneer crown preparation and endodontic access, there is often insufficient foundation for crown retention. In such cases, the cast post and core serves as the preferred coronoradicular stabilizer, especially for single-rooted teeth and premolars.

For multi-rooted teeth with significant loss of tooth structure, stock posts can be placed in more than one root to resist rotational forces, and a core can be constructed using well-condensed amalgam[8,17,26]. During the preparation for a custom-cast post and core, any gross undercuts in the pulpal chamber are either removed or filled with cement to ensure proper insertion. While undercuts can be advantageous for retention with prefabricated systems, they may be preserved in moderate coronal destruction scenarios, allowing the use of a prefabricated post and core system to maintain sound tooth structure and provide a retentive core.

It is often suggested that pulpless posterior teeth with minimal coronal destruction may not require posts for complete veneer crowns, a view that remains widely accepted. However, after endodontic treatment, adequately supportive dentin is seldom available, as such teeth typically have extensive restorations or caries, resulting in limited sound dentin.

Clinical and Laboratory Procedures

Post and Core Design

It is widely accepted that the cast metal post and core should be as long as practical, while maintaining an apical seal of 4 to 5 mm of gutta-percha. Ideally, the length of the post should equal or exceed the length of the clinical crown[4,26]. To ensure optimal strength of the remaining tooth structure, conserving sound dentin during post preparation and coronal restoration is essential. The post should not be excessively tapered, as this reduces retention.

Casting Procedures

The cast post should fit passively into the canal and remain stable without rotation or rocking after seating. Laboratories often create slightly oversized castings to improve the fit of extra-coronal restorations[26]. However, applying this approach to an internally fitting casting like a post and core can lead to an oversized casting, which may create a wedging effect and potentially fracture the root. When investing and casting posts and cores, some technicians use similar techniques to those for complete crowns but omit the ring liner to control expansion. While omitting the ring liner does not prevent setting and thermal expansion of the investment, it may lead to irregular expansion and possible distortion or cracking. A better approach is to use a ring liner or an asbestos substitute to promote uniform expansion and adjust casting procedures so that the mold expansion is less than the thermal contraction of the casting alloy. To produce a slightly undersized post, quartz investment (e.g., Beauty-Cast, Whip-Mix Corp.) and a low-temperature burnout (900°F for one hour) can be used[26]. To avoid hygroscopic expansion, the ring should not be immersed in water after investing. This method consistently results in well-fitting cast metal posts.

Cementation Procedures

Before cementing the post, the canal must be thoroughly cleaned of all debris, including lubricants. An extrafine brush (e.g., Proxabrush) attached to a hemostat can be used to apply a cleaning solution to the canal. A polycarboxylic acid liquid, such as Duralon liquid (Premier Dental Products Company), is an effective cleaning agent[21]. The brush acts like a bottle brush to clean the canal for 10 seconds, after which the canal should be rinsed with water for 30 seconds and dried with paper points. The surface of the post should also be cleaned, and air abrading the post before cementation can enhance retention. The cement should be mixed according to the manufacturer's instructions to ensure proper compressive strength and adequate working time. The canal walls are coated with cement using a lentulo spiral instrument or a Jiffy Tube applicator before the post is covered with cement and inserted into the prepared canal[21,26]. The post should be seated carefully to release hydraulic pressure and then gently reseated. This process is repeated until the post seats passively without rebounding.

Clinical Failures

Post Dislodgment

A post that is too short may fail to provide adequate retention, potentially causing dislodgment or leading to fractures due to unfavourable leverage. A short, wide post is particularly problematic as it offers minimal retention and weakens the tooth structure. Additionally, factors such as contamination of the cement with saliva, residual lubricant, or temporary cement can contribute to post failure.

Root Fracture

While post dislodgment is a significant issue, root fracture represents a more severe problem as it can make the tooth non-restorable. Vertical root fractures in endodontically treated teeth often prevent successful retreatment and

necessitate extraction. These fractures can be attributed to several factors, including the design of the post (e.g., tapered, parallel-sided, or threaded) and the hydraulic pressure during cementation. However, other factors can also contribute to longitudinal fractures. For instance, small nodules on a cast post can induce wedging stresses that lead to root fractures. An air bubble trapped during pattern investment can create a nodule on the metal post. If this nodule is not detected and the post is forced into place, the resulting stress concentration can lead to a wedging effect and root fracture.

To avoid these issues, custom cast posts and cores should be examined carefully under adequate lighting and preferably with magnification to identify any nodules before trial seating[26]. Positive casting defects, which are specific to the custom cast system, pose a disadvantage compared to prefabricated posts. Additionally, residual temporary cement from provisional restorations can also create similar issues if left in the canal space. Proper cleaning of the canal with a Proxabrush and polycarboxylic acid liquid before trial seating of the post is essential to minimize this risk.

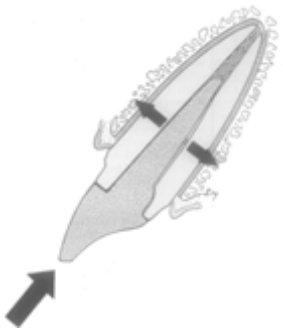

Fig 1 stresses acting due to vertical pressure

The risk of root fracture is reduced when the preparation for the coronal restoration conserves as much tooth structure as possible, thereby enhancing the ferrule effect[22,23,26]. Over-reduction during preparation for the artificial crown can lead to insufficient dentin coverage, increasing the likelihood of fracture. It is a common misconception that excessive reduction is beneficial because there is no vital pulp to avoid. However, this practice can be detrimental, especially if the finish line of the crown is at the same level as the finish line for the core.

Furthermore, undetected fractures may be present before the post and core are fabricated. Symptoms of cracked tooth syndrome might have prompted the initial endodontic therapy, and excessive force during obturation with lateral condensation of gutta-percha could have caused the fracture[26]. Once the post is cemented, any existing undetected fractures may propagate under functional forces and become more apparent over time.

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