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Review Article

Fiber-Post and Core: Some Clinical Considerations

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Abstract

The main goal of all dentists in the daily clinical work is to maintain proper Mastication, Occlusion and Appearance and Speech to their patient. Rehabilitation of endodontically treated teeth is one of the clinical challenges we face to reach our goal, where there is no one formula to use but varieties of situations confronting the dentist. Some factors need to be considered when using fiber post to restore the endodontically treated teeth.

Keywords: *Fiber-Post; Core; Mastication; Occlusion*

Introduction

Every day we open our eyes on new innovations in many fields including dentistry, which is rapidly growing.

With all these dental changes in materials, techniques and facilities, still our main challenge in daily dental practice is making decisions to save teeth to maintain proper mastication, Occlusion, appearance and speech.

Rehabilitation of Root Canal Treated (RCT) Teeth is a great challenge for dentist, specially if implant option cannot be applied.

Most if not all (RCT) teeth exhibit compromised structure duo to previous extensive caries, trauma or even old, big and failed fillings. Such teeth were rendered to more structural loss after Root canal treatment.

Few questions should be answered prior to making a decision of whether to save such a tooth:

- Does the patient value the tooth?
- Do we have the facilities?
- Do we have functional Opposing tooth?
- How important the tooth to our treatment plan? (E.g. avoiding distal extension for denture).

- Is the tooth restorable?
- Do we have favorable periodontal condition?

If a decision was made to save the tooth and a successful Root Canal Treatment was achieved, then, the next step is the Coronal restoration, to seal the canal and to reconstruct function and esthetic.

A radiographic study concluded that, evaluation outcome showed the quality of Root Canal treatment was more important than coronal restoration [1].

Other related study stressed on the Importance of final restoration after RCT [2].

Ray HA and Trop M [3] results showed that the quality of coronal restoration is more Important than endodontics filling and it is considered the most common cause of failure in RCT teeth.

In fact, it was found that bacteria could go inside the canal in a matter of days if gutta percha was exposed [4].

Another study, found that within 13 and day 37, bacteria had infiltrated all specimens of root canals through to the apex [5].

The previous studies emphasized on the Importance of coronal restoration but the selection of the final restoration for RCT teeth have always been Controversial.

The question is: Are we doing restorations as with any other destructed tooth or do we believe RCT tooth is different and it needs Special protocol regardless of the tooth position or How much tooth structure lost?

Some proposed that after RCT, part of the sensory feedback had been lost and the Patient will be biting more on the non-Vital than on other vital teeth.

Others believed that RCT teeth are more brittle [6] and dry So they are more susceptible to fracture.

On the contrary, laboratory studies showed equal fracture resistance for vital and non-vital teeth [7].

A compare study, of biomechanical properties (punch shear strength, toughness, hardness, and load to fracture) of RCT teeth and their contralateral vital pairs revealed no significant differences which indicates that teeth do not become more brittle following endodontic treatment [8].

Accordingly, the treatment of RCT teeth in many respect be Considered analogous in prosthetic treatment to Vital damaged teeth [9].

In both situations, we should consider:

- How much tooth structure left
- Tooth position
- Anterior or posterior tooth and
- Any para-functional activities.
- If the tooth abutment for a removable denture.

The fact, when considering restoring RCT teeth, they often have absolute loss of tooth structure, in which we cannot restore the coronal part without retention through a post extended from the root canal. So a post is needed to retain the core.

In the past, it was believed that posts extending to the root should help to reinforce the tooth and provide resistance to fracture [10].

A survey report among dentists in 1994 showed that 50% believed that post reinforce a pulpless tooth [11].

This believe, was questioned by many investigators. They reported that metal post with high modulus of elasticity will transmit the force to the root apex and increase the chance of root fracture [12].

A meta-analysis of literatures showed higher root fracture with metal post [13].

However, the correlation between a retrospective clinical and laboratory results showed no significant difference in teeth restored with or without metal posts and the strength of the tooth structure is related to the bulk of the remaining dentin [14].

Furthermore, the Survival of RCT teeth restored with post is directly proportional to the residual coronal dentin [15].

This was confirmed by other studies who reported that loss of tooth structure in general [16], including canal preparation for post [17] makes RCT teeth more susceptible to fracture and reduced the tooth fracture toughness.

So, the decision to use post when restoring RCT teeth should be based on remaining tooth structure after removing of all caries and old filling. Only if a significant portion of the crown is missing then there may be a need to use a post to provide the coronal restoration with necessary retention [18].

With the introduction of the fiber reinforced composite resin post in 1990 [19], the thought that post do not reinforce the tooth shifted to the concept that post may strengthen the tooth and make it more resistant to fracture [20].

Vitro studies on premolars [21] and maxillary incisors [22] showed higher fracture resistance in teeth with fiber post compared to teeth with no post.

Furthermore, a systematic review concluded that currently used fiber post represent the best treatment option [23] and was proposed as a valid alternative to metal posts [24].

Fiber-reinforced posts are made of bundles of black carbon fibers embedded in resin matrix; usually epoxy resin, which later are coated with quartz. Or the carbon fibers are replaced with glass or quartz fibers for esthetic purpose.

The aims of such materials are: to provide posts with complementing stiffness and flexural strength to dentin, can be bonded to dentin, better esthetic, easily retrieved and time saving procedure.

It has been suggested that fiber-post with lower modulus of elasticity (stiffness) similar to dentin acts as a shock absorber. It will absorb the force and transmits only limited amount of stresses to the residual tooth structure.

Its, Flexural strength that can be as flexible as dentin will allow post to behave similar to the tooth structure under force and reduce incidence of tooth fracture compared to metal post [13].

Several studies have examined posts and cores that are of various rigidity and demonstrated that, rigid materials resisted greater forces without distortion. Therefore, there may be a potential danger in using highly rigid posts [25].

Vitro studies (Schwartz and Robbins 2004), as well as Prospective [26] and retrospective [27,28] clinical studies found less fracture incident of fiber post compared with other metal posts).

Although the previous studies reported evidence on fiber -post as a good option, other studies have expressed concerns regarding the promises regarding fiber post physical properties.

Vitro study indicated that the form of the post it self influenced its rigidity and found that a smooth fiber-post less flexible than serrated [29].

Also, the flexural characteristics of the post influenced by mis-match of the post form compared to the canal configuration [11].

On a laboratory study, deterioration in flexural properties was observed with cyclic loading [30].

In addition, the flexural strength of the post decreased with thermocycling or when immersed in water duo to degradation of the matrix [31].

Vitro [32] studies and clinical follow up studies for 3 years [33] and 5 years [34] conducted that the overall incidence rate of root fracture was similar between metal and fiber-post.

In fact, the mismatch does not increase the risk of root fracture; it is responsible for the de-bonding of the post and core, which causes root fracture indirectly [35].

Recently resin based composite cement is becoming increasingly popular because its potential to bond to dentin.

Therefore, using such materials with fiber posts had been shown to provide root reinforcement [36].

When comparing the stresses transmitted by cemented metal post, it was found that the bonded post transmitted less stresses than cemented metal post [37].

It has been postulated that reinforcement of the tooth is duo to the stress distribution characteristics of the bonding materials 28 [38].

Where a multilayered structure bonded with no inherent weak inter layer interfaces. Resin bonded directly to both dentin and post as well as to core then to the crown to create Monobloc, where the integrity of the final RCT tooth approaches that of the original healthy tooth [39].

However, there is evidence that, the presence of a bonded post neither reinforces nor strengthens the root of RCT tooth.

In fact, the post located centrally in the neutral axis (not in tension or compression). The stress during function is concentrated to the circumference of the tooth whereas the stress level is lowest within the root canal [40].

With elastic posts, the tooth, cement and post will all deform during function. Failure will appear at the circumference, weakest point of the tooth, which seems to be the adhesive point at the core-dentin and post-cement-dentin interfaces.

This biomechanical approach is supported by a number of studies [18].

Laboratory studies have shown elastic posts have a lower tendency to cause root fracture than posts of higher stiffness [41]. However, it can cause failure of the cement seal at the margin of the crown.

Figueredo [42] in mid line study did not show a significant difference for RCT fracture incidence between metal and fiber post until 5 years but there was a higher incidence of non-catastrophic failures for fiber post.

When limited tooth structure remains coronal to the gingival margin, the physical properties of the post influences the long–term prognosis of the restored RCT tooth [43].

More likely, fracture resistance may be more dependent on the amount of remaining sound dentin [44].

With enough ferrule, post selection doesn't make any difference. In contrast, with no ferrule we will have either crown leakage with the flexible post or root fracture with stiff post!!

It is claimed that bonding of the post securely with adhesive materials to the tooth structure should improve the prognosis by increasing retention of the core to the tooth.

Some studies have reported significant higher retention with resin [45].

Several studies found that the results were conflict for adhesive cements and they played non-significant role in the prognosis [18]. In fact, the fundamental biomechanical principles are more important if followed.

It was found [46] and with an agreement with other studies [47] that the fiber posts, similar to metal posts relies mainly on mechanical retention rather than bonding, which is due primarily to the unfavorable bonding environment of the root canal system.

The establishment of a valid micromechanical intra-radicular bond is indeed challenged by several limitations [46] among which seems to be:

1. Polymerization shrinkage which causes stress on dentin, that exceeds the bond strength between dentin to cement [48].
2. Deterioration of the resin bond with time which was documented *in vivo* [49] as well as *in vitro* [50] studies.
3. The adverse effect of eugonol on resin. Some advice, to remove it by irrigation with ethanol or etching with 37% PH acid.
4. The configuration factor CF (Ratio of bonding: un bonded resin surface) [51]. The higher the percentage of bonded surface compared to non-bonded the more stress on bonded surface from polymerization contraction in root canal. Since all surfaces are bonded so considered unfavorable for bonding.
5. Irrigation with sodium hypochlorite (oxidizing agent) will leave oxygen behind which inhibit the resin polymerization. Using reducing agent, ascorbic acid and sodium ascorbate then soak with EDTA, found to be effective for bonding [52].

Furthermore, Acid-etching of the post space and an EDTA irrigation combined with ultrasonics are also effective in obtaining a clean post space [53].

Other way by removing Gutta, Percha then pumice with slurry before acid etch with phosphoric acid 37%.

On the contrary, scanning electron microscopy observed Limited decalcification/infiltration for self-adhesive cements into the underlying dentin [54], while Conventional acid etching resulted in partially infiltrated adhesive interfaces.

Although, Resin luting agents showed good adhesion to glass fiber post [55,56], other studies questioned the bonding between Post and resin.

It was found that the retention of serrated post to composite was twice higher than fiber post [30], when serration added to fiber post similar result found. This finding confirmed that the bond between post and resin cement is mainly mechanical.

Another factor that influence the bonding to fiber post is that, the epoxy matrix in the industrially processed post is highly polymerized and farther chemical reaction between matrix and cement should not be expected.

While Several surface treatment of post have been recommended to enhance the bonding like, Silane application and sandblasting, other Studies showed negligible effect with silane [57]. And very little improvement found with sandblasting [58].

Other modality was suggested, by inserting the post for 10 - 20 minutes in Hydrogen peroxide and sodium ethoxide for conditioning the resin and expose the area by breaking epoxy resin bond before silane application [54].

The previous factors bring us to the problem that a reliable bonding in root canal dentin is not easily achieved.

This is reinforced by the results of some studies which showed that, loss of retention was the most frequent and unfavorable event for post retained restoration [59].

The amount of information and results available from laboratories and retrospective and prospective clinical studies are massive and over growing. However, they are contradictory and made it difficult to recommend direct fiber post restoration superior to other treatments.

There are inconsistency of the clinical published data, In addition, that the factors in relation to the issue are not described in most of the studies. Such as, the amount of remaining tooth structure, length of ferule, occlusion and position of tooth. These explain the limitations and the need for highly randomized controlled prospective clinical trials [60].

Conclusion

- Techniques and materials keep changing but our ultimate goals of treatment are constant.
- The clinical decision as to which post to use is always a challenge to dental practitioners.
- The main function of the post is to anchor the post and core complex.
- As far, the post does not reinforce the root, nor give more strength. Therefore, it is important to select a post system that provides maximum retention, yet remove as little as possible of tooth structure.
- When substantial coronal tooth structure needs to be removed to develop a path of insertion for the casting post!! a prefabricated posts more preservative of tooth structure.
- Resin-based cement will not miraculously improve clinical situation and prognosis of structurally compromised tooth or short root. However, in clinical situation where all effort are needed to save the tooth, then the choice of cement may become important.

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