

# Dental materials



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In a dental practise, it is frequently difficult to restore devitalised anterior teeth, as it poses several challenges. The dentist should be able to judge from clinical experience and training to the extent to which a tooth that is non-vital and fractured can be restored and contribute to the oral health of the patient. Several factors that exist or operate in the mouth need to be taken into consideration. Sometimes, a tooth that may not cause any serious problem if restored, may prove to serve an important functional asset in the mouth.

In such cases, it would be very unwise to remove such a tooth. The dentist should also not consider that in every case a tooth, which is fractured and devitalised, could be restored. In every case, the factors that could play an important role in the outcome of such treatment should be determined. It is important that the tooth has good periodontal support. Besides, the restoration made should also be appropriate. Frequently, dentists would like to treat the tooth endodontically and then plan of how the tooth should be restored.

However, the dentist should be able to decide the restorative treatment before the tooth is treated endodontically. In case of great number of difficulties, it may be necessary to extract the tooth, and in such cases endodontic post and core may not seem feasible. The dentist should also consider that newer materials and techniques have come out, which has made the process of restoring a tooth with post and core much more easier, and which has also resulted in improving the outcome. When a post is placed into an endodontically treated tooth, it is able to support a core.

This core would serve as a base or a foundation for the restorative material. It would not be providing any kind of reinforcement (Charbeneau, 1989). The post and core restoration consist of several components, namely, the post, core, external restoration and the luting cement. The post and core system should possess certain characteristics, which would ensure that the tooth functions appropriately.

This would also prove to be a huge benefit of the individual's oral health. For a post and core restoration to be successful, it should have a good design and use appropriate restorative materials. Besides, the preparation should be made keeping technical considerations in mind. The restoration should have a retentive form and a resistance form. In anterior teeth, it is important that the restoration is aesthetically appropriate and if there is a need to retreat the tooth, considerations should be incorporated (ADA, 2006).

Restoring endodontically treated teeth There may be several problems whilst restoring endodontically treated teeth. When tooth become non-vital, they may get dehydrated and hence, become more brittle. They may break when minimal pressure is applied. Further, during the endodontic treatment, instrumentation tends to weaken the tooth further leading to fracture. Compared to normal vital teeth, there is a 9 % loss of free water in the structure.

The tooth has to be restored immediately with cuspal coverage, as the space that is occupied by the pulp is now a dead empty space (Charbeneau, 1989). A ferrule preparation on the gingival margin of the restoration to ensure that the restoration can derive some amount of resistance form is made in case

of certain post and core restorations. It also provides resistance from rotational forces.

The preparation is made in the gingival margin so that the material can extend for 1 to 2 mm. This kind of preparation would ensure some amount of aesthetics in the gingival margin. The resistance to fracture was also greater when a ferrule was placed (ADS, 2006). Some studies have demonstrated that when the length of the ferrule was increased, the resistance to fracture also increased.

#### Characteristic Features of the Post

1. The ideal length of the post required to provide an appropriate restoration is still under a lot of speculation. Several factors need to be taken into consideration including the status of the periodontal structures, the applicability of the occlusal forces, the length of the root, etc. In compromised situations, the length of the post should be at least equal to that of the crown. To provide retention, the length of the post should exceed that of the crown adequately (Charbeneau, G. T., 1989). If the length of the post is increased and if the post is kept thin, the amount of shear stresses would be kept minimal. This would help prevent internal fractures from developing (ADA, 2006).

2. The post should not impinge on the apical region of the tooth. In order to prevent leakage occurring at the root apex, it is necessary to maintain a distance of about 6 mm from the root apex. This space should be filled up with gutta percha that would be ensuring that there is a hermetic seal. Below 3 mm, the gutta percha may not offer enough sealing properties.

3. The post should be able to absorb all the forces of the external restoration and transfer it to the root and the periodontal structures. Studies have demonstrated that if the post has sides that are parallel rather than tapered, the forces are better distributed. The retention is better in parallel post, but not as high as that of the threaded posts.

4. Studies have demonstrated that if the diameter of the post is increased, there were chances that the retention of the restoration would also increase. However, this would seriously compromise on the strength of the remaining root structure. Studies have shown that if the thickness of the root were compromised, there would be a decrease in the resistance of the tooth. Hence, it is very important that the thickness of the post is balanced so that an important portion of the remaining tooth structure is not destroyed. Studies have also shown that having a wider root canal prepared to receive a thick post would increase the risk of perforating the root canal. This would be a serious complication, and frequently would require extraction (Charbeneau, G. T., 1989).

The material to be utilised to fabricate the Post Several factors need to be taken into consideration.

These include 1. The mechanical properties of the post – The post has to possess certain amount of mechanical strength, rigidity and flexibility. Many materials can be utilised to make the post including ceramics, metal and carbon fiber. Metal and ceramic posts are strong and rigid, and do not possess as much flexibility as possessed by a fibre post. Compared to metal and ceramic posts, the chances of fractures are very low with fibre posts.

Hence, the clinician should use his judgement to ensure that a balance between flexibility and strength is maintained.

2. Aesthetics is a very important criteria required for an anterior restoration. It is very important that the external restoration be made of ceramic fused to metal, to ensure that the post does not interfere with the aesthetics. Effectively, if the external restoration is made out of ceramic fused to metal, the material out of which the post is fabricated will not matter, aesthetically. However, several factors play a role in determining whether ceramic fused to metal is utilised as an external restoration. The metal post may cause a greyish discoloration of the gingival region and the aesthetic restoration. Carbon-fibre posts may also not appear aesthetic. However, the dentist could consider using a light-coloured fibre post or a ceramic post. Posts made of glass, silicone or quartz could also be considered for use, as they appear translucent and would not hamper with the aesthetic appearance.

3. The clinician should also consider the need for re-treatment whilst placing the post initially. Besides, the need to use a radio-opaque material for monitoring through X-rays is also required. This would especially help in cases where there are high chances of flare-ups following endodontic treatment. Metals can easily be identified on the radiograph, as they are radio-opaque. With relation to fibre post, the materials used to make the post play a very important role. The manufacturers frequently utilise a radio-opaque agent in the composition to make the post appear on the X-rays. About 50 % of the posts available in the market are known to have opacity similar to that of gutta percha. It is very important for the clinician to determine the density of the post through specifications given on the pack.

Clear differentiation of the post from that of the dentine should be possible. The dentist should consider using radio-opaque cement in case the radio-opacity is less than that of dentine.

4. Removal of the post – In many cases (especially in which the chances of re-infection are high), there is a need to perform re-treatment of the tooth. In such cases, there would be a need to remove the post, by several methods including physical, chemical, mechanical, etc. A metal post can easily be removed without damaging the tooth utilising ultrasonic and mechanical methods. A fibre post would require the use of rotary cutting instruments to help in the removal. It may be very tough to remove a ceramic post, as several processes should be employed. Many manufacturers would consider that the clinician should not use a ceramic post in case there was a need for re-treatment. The clinician should consider the thickness of the remaining root material before selecting any material to insert.

5. The shape of the post also plays a very important role. The posts having parallel sides are more likely to distribute the stress onto the root walls better, compared to the tapered posts. The risk of root fractures is higher with tapered posts as the load may not be evenly distributed onto the root length. Parallel posts are also more retentive than the tapered posts. As the parallel post does not confine to the walls of the root canal, it requires more tooth material to be cut. Hence, only if sufficient thickness of the root walls is existent, can a parallel post be used. In anterior teeth, if the walls are thin, parallel posts should be utilised, as the chances of perforation are very high. Tapered posts tend to transfer the stresses to the apex of the root, thus increasing the chances of the tooth developing vertical fractures. Studies

have shown that failures of the endodontic and the post and core treatment are high when tapered posts are utilised. However, frequently in anterior teeth, which have thin roots, tapered posts should be utilised.

6. Threaded posts offer the greatest amount of retentive form compared to tapered or parallel posts. However, the chances of root fractures are very high as internal stresses are present. In a threaded post, retention derives from the threads. This type of a post is known as 'active post'. A passive post is one, which derives a greater amount of retention from the cement utilised. The chances of internal stresses building up and subsequent failure due to root fractures are less with passive posts. However, the retention in a passive post can be improved by placing roughened surfaces.

7. Diameter of the post also plays a very important role in determining the amount of strength and resistance that could be achieved clinically. If a post is thick, the retention would improve, but the strength of the remaining tooth material would be seriously compromised, due to the extensive preparation. Besides, the process of placing the post may also be harmful to a wall that has been excessively trimmed.

The Core materials Several materials are used to build up the core in the anterior restoration. Some of the common core materials that can be utilised include composite restorations and modified GIC cements. As the amount of tooth material present in the teeth decreases, it is more and more important that the remaining core material performs its functions in a more crucial manner. A core material requires several characteristics including

1. Compressive strength
2. Resistance to shearing forces
3. Biocompatibility
4. Easy manipulation
5. Should be able to bond to the tooth structure
- 6.



Should prevent the microleakage between the tooth and the core material 7. Should have a coefficient of thermal expansion which is identical to that of the tooth 8. Should be dimensionally stable 9. Should be thermally insulating 10. Should not dissolve or absorb water 11. Should offer some amount of resistance from dental caries 12. Should be aesthetically suitable

However, it may not be able to find a single material that would possess all these characteristics. Hence, any material that is being utilised as a core material would have certain strengths and certain weaknesses. If a ceramic-metal external restoration is utilised, then the core material need not have any aesthetic considerations. Even metallic restorations, amalgam, cast gold, etc, could be utilised. Amalgam and cast gold restorations have high compressive strength and have very low solubility.

Amalgam takes a long time to set and cast gold restorations usually requires about 2 sittings. However, amalgam requires a lot of special features for it to retain in the prepared tooth cavity (Cheung, W., 2005). Composite resin is one the most commonly utilised core material for anterior teeth. It is very less soluble in oral fluids and has a good strength. It is aesthetically superior and can be utilised below ceramic external restorations (Cheung, W., 2005). Besides, it has also good amount of resistance from fractures (Kutesa-Mutebi, A. & Osman, Y. I., 2004). However, a composite restoration also possesses a lot of negative features.

It tends to undergo polymerisation shrinkage leading to destruction of the bond formed between the restoration and the tooth material. This shrinkage would also permit microleakage leading to secondary caries. The composite material also tends to absorb water leading to expansion. During

manipulation, voids tend to form within the core material. Several chemicals that are utilised as root canal materials such as eugenol, cannot be utilised along with composite resin core as it softens the composite (Cheung, 2005). Modified-GIC cements can also be utilised as core materials.

The conventional GIC material offers poor compressive and tensile strengths and tends to fail. The GIC cement would bond to the tooth material, chemically. GIC cement is anti-cariogenic in nature as it leaches out fluorides, thus preventing caries from forming. Special preparations are usually not required for GIC cements. However, there are also several limitations of GIC cements. It offers very low modulus of elasticity and is highly soluble in oral fluids. GIC should preferably not be utilised as a core material (Cheung, 2005).

Ceramics can also be utilised as a core material. It has a lot of advantages as well as disadvantages. It has a high modulus of elasticity and a low flexural strength. The material is one that is aesthetically suitable and is very biocompatible (Ahn, S. G. & Sorensen, J. A., 2005). Studies have shown that overall; a lot depends on the presence of a ferrule in reducing the risk of a fracture in all-ceramic and ceramic-metal cast post and core restoration. The presence of a 2 mm ferrule in the gingival margin significantly helped to reduce the chances of fracture of endodontically treated teeth from developing. It protects the root from any counteracting forces that are produced by the presence of the post.

The ferrule may not be of much use when cast metal post and core restorations are utilised. The ferrule helps to resist any stress that develops from the occlusal forces. It also ensures that stresses do not build up at the

interface of the post and the core. If a ferrule is not placed, then all the occlusal forces are transmitted to the post, leading to increased chances of developing fractures (Zhang Yu-xing, Zhang Wei-hong, LU Zhi-yue, 2006). Studies have shown that in situations in which the remaining coronal dentin was greater than 2 mm, a ferrule was actually not needed (Kutesa-Mutebi, A. & Osman, Y. I., 2004).

Nowadays, ceramic restorations are increasingly being utilised as restorations in anterior teeth and findings that the presence of the ferrule in the gingival margin could help to prevent the development of fractures. As an alternative to ceramic restorations, resins or metal restorations can be utilised with a ceramic fused to metal external restoration. Ceramic restorations may frequently fail if the compressive strength is reduced. Ceramic also tends to have very good marginal fitting. It can be to any surface with the help of cements.

The external restoration Several restorative materials can be used as external restorations over the prepared core material. Full-ceramic and metal-ceramic materials are more commonly utilised. They protect the post, core and the tooth and help to restore normal function and appearance. It is important to remember, that the process of periapical infection, preparation of the endodontic access cavity, etc, will reduce the strength of the tooth and make it more susceptible to fracture. The amount of remaining tooth material present play an important role in protecting against fractures (Cheung, W., 2005).

Several luting materials are utilised to cement the post to the walls of the root canal. These include zinc phosphate, zinc oxide eugenol, GIC, and resin-

modified GIC cements. Zinc phosphate has very good compressive and is specifically useful when tapered posts are to be utilised. GIC and polycarboxylate cements seem to be useful when parallel-sided posts are utilised. GIC may deteriorate in a dry environment, but bonds with the dentin. It also offers anti-cariogenic properties. Modified-GIC has better retentive properties compared to the conventional GIC cement (Rickets, D. N. J., Tait, C. M. E, & Higgins, 2005).