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Monoblocks in root canals – a real or theoretical goal

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Abstract

With the recent interest in the application of dentin adhesive technology to endodontics the term "monoblock" has become very familiar in the endodontic literature. There has been a controversial discussion between academicians and clinicians regarding endodontic "monoblocks", whether they are able to improve the quality of seal in root fillings and to strengthen the roots. This review is an attempt to venture a broader meaning to the term "monoblock". The potential of available bondable adhesives to achieve mechanically homogenous units with root dentin is discussed in relation to the classical concept in which the term "monoblock" was first employed in restorative dentistry as well endodontics.

Key words- monoblocks, rootcanal, endodontics

Introduction

Endodontic recuperation is a demanding and complex procedure. Challenges like dental caries, abrasion and trauma alter the tooth structure and weakens them. To achieve caries free, straight- line access in non vital tooth, leads to further weakening of the tooth structure. Therefore, in such cases the treatment option should not only restore the tooth, but also reinforce the structurally compromised tooth. The search for such an ideal material has given rise to the concept of endodontic monoblocks. [1-3]

The term monoblock literally means a single unit. The concept of monoblock in endodontics was first described by Franklin R. Tay. For a monoblock to function successfully as a mechanical homogenous unit two prerequisites are required simultaneously

The first prerequisites is, the material that constitute a monoblock should have the ability to bond strongly and mutually to one another, as well as to the substrate that monoblock is meant to reinforce. Secondaly , these materials should have modulus of elasticity that is similar to that of the substrate.[1]

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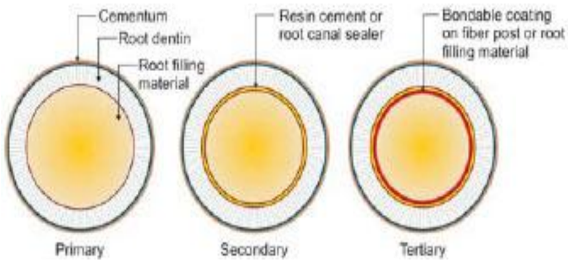

Fig.1: *Cross-sectional illustration demonstrating the types of monoblocks*

Replacement monoblocks created in the root canal spaces may be classified as primary, secondary and tertiary depending upon the number of interfaces present between the bonding substrate and the bulk material core. [1]

Primary Monoblocks

A primary monoblock has only interface that extend circumferentially between the material and the root canal wall. A classic example of primary monoblock is use of Hydron sealer. In the late seventies, a 2-hodroxylethyl methacrylate (HEMA) containing root filling material, Hydron (hydron Technologies, Inc., Pompano Beach, Florida, USA) was marketed commercially for en masse filling of root canals. [4] Polymerization of HEMA takes place in presence of water. It forms soft hydrogels that are highly permeable and leachable. Many studies have demonstrated that Hydron- filled root canals exhibited extensive leakages.[5]

Endodontically treated teeth roots are more prone to fracture.[6-9] In order to reinforce the roots the material should fulfil the second prerequisites of monoblock i.e. the modulus of elasticity of a root filling material should be approximate that of dentin (i.e. 14,000 MPa). The first monoblocks employed in root canals (Hydron) due to lack of stiffness could not strengthen the root canal surfaces.[10]

Another material used as a primary monoblock is mineral trioxide aggregate (MTA, Dentsply Tulsa Dental, Tulsa, OK). MTA is used as an apexification material and strengthens the immature tooth roots. Principal composition of MTA is Portland cement with addition of bismuth oxide which is to provide it radiopaqueness.[11, 12] As Portland cement is an inorganic material, it goes under chemical shrinkage following hydration.a certain amount of volumetric shrinkage also occurs during the setting of MTA. There is no bonding of MTA to dentin. Released calcium and hydroxyl ions of MTA interact with phosphate-containing synthetic body fluid of apatite-like interfacial deposits.[13, 14] The gaps induced during the material shrinkage phase are filled up by these deposits. So the lack of bonding of MTA to dentin, and that it has high stiffness in compression, it has little strength in tension leads to inability of MTA to strengthen the roots.

Thus due to the lack of sufficient strength and stiffness being major drawback of Hydron and the inability of MTA to strengthen roots led to development of secondary monoblocks.

Secondary monoblocks

Introduction of an additional interface in monoblock was the combined use of a core material and a cement/sealer in contemporary endodontic obturations and adhesion of fiber post.

Secondary monoblocks are those which have two circumferential interfaces, one between the cement and dentin, the other between the cement and the core material.

Around 2004 the concept of monoblock to reinforce the root canal space was resurfaced with the arrival of bondable root filling materials that were launched as an alterantive to conventional gutta-percha as obturating materials.[15]

A secondary monoblock is classically perceived in the restorative and endodontic literature. Root canal obturations, are the indirect fillings of the root canal space created by cleaning and shaping, may be regarded as secondary monoblock systems. However, the conventional root canal sealers do not bond strongly to dentin and gutta-percha ,[16]and they also do not behave as mechanically homogenous units with the root dentin. Even though glass ionomer cements and resin-modified glass ionomer cements bond to root dentin and are used as root canal sealers [17, 18], they do not bond to gutta-percha. Even if they bond, the modulus elasticity of gutta-percha points (ca. 80 MPa) [19] is 175–230 times lower than that of dentin (ca. 14,000–18,600 MPa) [19, 20, 21], making them not stiff enough to reinforce the tooth roots after endodontic therapy. Thus, it is totally uncertain that a glass ionomer-based sealer can be strengthen the endodontically treated tooth roots and prevent root fracture in gutta-percha filled root canals [22]. Till now , there are three bondable root filling materials available commercially. Of these, Resilon (Resilon Research LLC, Madison, CT) is the only bondable root filling material , used for either lateral or warm vertical compaction techniques. Resilon is applied using a methacrylate-based sealer to self-etching primer treated root dentin, therefore it contains two interfaces, one between the sealer and primed dentin and the other between the sealer and Resilon, and hence may be classified as a type of secondary monoblock. Initially Resilon-filled root canals were found to be better than conventionally gutta-percha filled canals in preventing bacterial leakage [23] and improving the fracture resistance of endodontically treated teeth [24]. Based on these promising properties, Resilon, along with the Epiphany primer and sealer system (Pentron Clinical Technologies, Wallingford CT) was subsequently referred to as the Resilon Monoblock System (RMS) [25, 26] that creates ideal root obturations in terms of both coronal sealing and fracture resistance [27]. Although Resilon-filled root canals do produce good apical and coronal seals, it is inexplicit from many independent research studies, if such seals are better than those achieved using gutta-percha and conventional root canal sealers [28-31].

All adhesive restorations are tend to create interfacial stresses during polymerization due to the intrinsic volumetric shrinkage because of conversion of double bonds to single bonds. Polymerization shrinkage stress can lead to debond adhesive interfaces [32, 33]. There is increase in stress as the volume to surface area ratio increases. Therefore, here the cavity or “C-factor” is very important. In a class I cavity, there are five bonded cavity walls and only one (i.e. occlusal) unbonded "wall" such a cavity has a C-factor or 5/1 or 5. In root canals, C-factors can be over 1000 [34]. Any polymerizing endodontic sealer may be subjected to large polymerization stresses while their setting which may lead to debonding and gap formation along the periphery of the root filling. The extremely high C-factor in root canals has been considered as a possibility for not achieving perfect seals in Resilon-filled root canals [34].

The bondability of Resilon to methacrylate resin-based root canal sealers is supposed to be derived from the inclusion of the urethane dimethacrylate resin. However, the concentration of the polymeric components, may not be optimized for optimal adhesion of the root filling material to the methacrylate resin-based sealers.

Recently published research further indicated that there is no difference between Resilon and gutta-percha in strengthening and reinforcement of immature roots [35].

Tertiary Monoblock

Tertiary monoblocks have an additional third circumferential bonding substrate and the abutment material. Fiber posts containing either an external silicate coating or those containing unpolymerized resin composite for relining the wide root canals or not perfectly round for fitting of conventional fiber posts may be considered as tertiary monoblocks.

The introduction of a tertiary interface is intricate in that gaps present between the fiber post and the relining composite [36]. These gaps may raise the stress and result in eventual adhesive failure and dislodging of the fiber post from the relining composite.

Obturating material like EndoRez which is a conventional gutta percha coated with proprietary resin coating. This coating is created by first reacting one of the iso-cyanato groups of a di-iso-cyanate with the hydroxyl group of a hydroxyl-terminated polybutadiene, as the latter is bondable to the hydrophobic polyisoprene component of the gutta-percha cones. Next is the grafting of a hydrophilic methacrylate functional group to the other isocyanato group of the di-isocyanate, producing a gutta-percha resin coating that is bondable to a hydrophilic, methacrylate-based dual-cured resin sealer [37]. In this system the root dentin is not primed with an adhesive, as the adhesion depends upon the penetration of sealer into the dentinal tubules.

Although the tensile bond strength [38] and apical seal both [39] of the EndoRez system to intraradicular dentin may be improved using a dual-cured self-etching primer/adhesive such as Clearfil Liner Bond 2V (Kuraray Medical Inc.), as a potential problem of rapid polymerization of the adhesive is seen in an environment with reduced oxygen concentration. Moreover, even with the adjunctive use of an adhesive, it is not possible to expect the establishment of a mechanically homogenous unit with the root canal with the EndoRez system, as the bulk of the material inside the root canal still consists of thermoplastic gutta-percha, an elastomeric polymer that flows when stressed.

In ActiV GP (Brasseler USA, Savannah, GA), the root filling system is marketed as a monoblock system by using conventional gutta-percha cones that are surface-coated with glass ionomer fillers using a proprietary technique [40]. By this technique, a stiffer gutta-percha cone is achieved that transforms it into a gutta-percha core/cone, enabling the latter to be functioned as both the tapered filling cone and as its own carrier core, therefore avoiding the need for a separate interior carrier of plastic or metal [41].

The system produced apical seals comparable to that of gutta-percha and AH Plus sealer (Dentsply Caulk, Milford, DE) [42]. Although , being a single cone technique, coronal leakage of the ActiV GP system to fluid filtration was not good whencompared to that achieved with gutta-percha/AH Plus, may be due to the increase in the volume of the glass ionomer cement sealer [42]. The difference between the apical and coronal fluid filtration results could be reflected when the same systems were evaluated using a bacterial leakage technique, here ActiV GP demonstrated more severe bacterial leakage compared with gutta-percha/AH Plus (Monticelli et al., unpublished results). For the reason mentioned previously, it is also not likely that the use of the ActiV GP system will improve the fracture resistance of endodontically treated teeth.

Conclusion

Although the concept of creating mechanically homogenous units with root dentin looks excellent in theory, accomplishing these "ideal monoblocks" in the root canal space is easier said than done. Primary monoblocks have lower magnitude of stresses when compared with secondary and tertiary monoblocks. As close is the elasticity of modulus of the replacement monoblock to dentin the lower the stress is produced. MTA as an obturating material does not create better monoblock. Whereas, Resilon could serve as an ideal monoblock material in mature roots, as the stress distribution pattern is similar to that of natural teeth

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