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Monoblocks in root canals: A review

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***Abstract*---**The term “monoblock” has become a familiar term in the endodontic literature with recent interest in the application of dentin adhesive technology to endodontics. Endodontic “monoblocks” have generated controversial discussions among academicians and clinicians as to whether they are able to improve the quality of seal in root fillings and to strengthen roots. The ultimate challenge for successful endodontic therapy is to establish a homogenous unit of the root canals which requires a hermetic seal. Adhesion of root canal sealers to dentin is important to seal the root canal system thoroughly and to prevent microleakage. Bonding of root filling materials to the radicular dentin is known as ‘monoblocks’ which has become more popular after introduction of bonding concept in the root canal system.

***Keywords*---**monoblocks, MTA, fibre posts, bonding root canal.

Introduction

The literal meaning of the word monobloc is ‘Single unit’. It has been variously defined as either a forging or casting made in a single piece, rather than being fabricated from separate components. The introduction of the word ‘monobloc’ to dentistry can be traced back to 1902, in the field of orthodontics, by Dr. Pierre Robin. It was he who first united upper and lower acrylic removable appliances to treat certain syndromic patients. This appliance went on to emerge as the precursor of functional appliances used in orthodontics. However, in Endodontics

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it was Franklin R Tay who introduced the monobloc concept. (Benkel BH,1976). [1] In endodontics the term monobloc is used to signify a scenario where in the canal space is perfectly filled with a gap-free, solid mass that consists of different materials and interfaces with the purported advantages of simultaneously improving the seal and fracture resistance of the filled canals. This gap free solid mass filling may imply either a root canal obturating material or a post and core system. In fact this philosophy was first popularized in 1996 with the bonding of carbon fiber–reinforced posts to root mechanically homogeneous monoblock. [1]
Based upon these interfaces monoblocks are classified into :

- primary monoblock,
- secondary monoblock and
- tertiary monoblock.[1]
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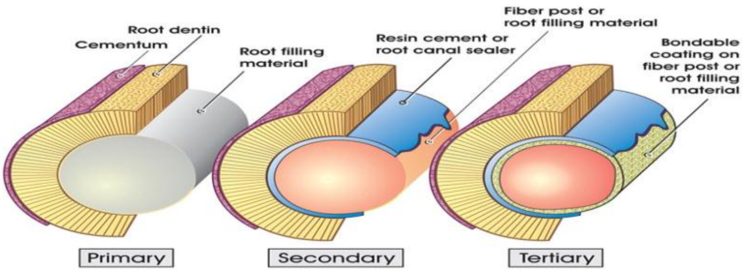


CLASSIFICATION OF ENDODONTIC MONOBLOCKS

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. Secondly, these materials should have modulus of elasticity that is similar to that of the substrate.[2]

Primary Monoblock

Has only one interface that extends circumferentially between the material and the root canal form. 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.[3] 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.[4]

Materials used: -
- Hydron
- Mineral trioxide aggregate
- polyethylene fibre post-core systems
- Biogutta.
- The materials under primary monoblocks can be manipulated easily, non-irritating with acceptable adaptability, and ability to calcify even if it gets forced out of the canal accidentally. MTA helped in fortifying the teeth by forming interfacial apatite deposits resulting in good seal.[5]

Hydron:

- The modulus of elasticity of hydron is less than that of dentin which is not acceptable in creating the primary monoblock for fortifying the roots.[6]
- Poly (HEMA) was used in its optimally polymerized form which polymerizes in the presence of water to form soft hydrogels that are highly permeable and leachable.
- The first monoblocs employed in root canals (Hydron) due to lack of stiffness could not strengthen the root canal surfaces.[7]

MTA

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.[8,9]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.[10]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. The inability of MTA to strengthen roots is probably a combination of its lack of bonding to dentin and its low tensile strength even though it has high compressive strength.

Biogutta

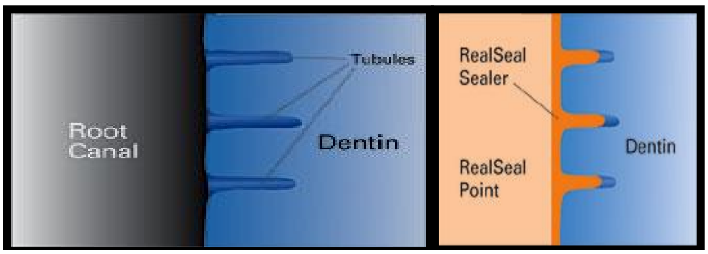
Biogutta which contains polyisoprene matrix with bioactive glass of 45s5 type which exhibits self-adhesive property with immediate sealability.[11]

Secondary Monoblock

The system in which two circumferential interfaces are formed one between the cement - core material and other between cement-dentin are categorised as 'secondary monoblocks. 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 [12]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 [13,14] they do not bond to gutta-percha. Even if they bond, the modulus elasticity of gutta-percha points (ca. 80 MPa) [15] is 175–230 times lower than that of dentin (ca. 14,000–18,600 MPa) [15,16,17] 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 [18]. 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 [19] and improving the fracture resistance of endodontically treated teeth [20]. 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) [21,22] that creates ideal root obturations in terms of both coronal sealing and fracture resistance [23]. 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 [24]

- Ex:resilon, Fibre re-inforced posts. A polycaprolactone based bioactive containing glass such as resilon shows good bonding ability with the sealer through the process of polymerization.[25]
- The epoxy resin embedding matrix is also replaced with highly cross linked methacrylate resin matrices which have potential to bond to methacrylate- based resin cements.
- Resilon Research LLC, Madison, CT) is the only bondable root filling material that may be used for either lateral or warm vertical compaction techniques. As Resilon is applied using a methacrylate-based sealer to self etching primer–treated root dentin. [26]

Resilon Epiphany System



Resilon Dentin Interface

The modulus of elasticity of Resilon is 86.6 ± 43.2MPa under dry conditions & 129 ± 54.7 MPa after water absorption. [26]

Tertiary Monoblock[7]

Those in which a third circumferential interface is introduced between the bonding substrate and abutment material. The introduction of a tertiary interface is intricate in that gaps present between the fiber post and the relining composite [27]. These gaps may raise the stress and result in eventual adhesive failure and dislodging of the fiber post from the relining composite.

Fiber posts that contain either an external silicate coating (DT Light SL, VDW GmbH, Munich, Germany), or those that contain unpolymerized resin composite for relining root canals that are too wide or not perfectly round for the fitting of conventional fiberposts (Anatomic Post, RTD, St. Egéve, France) may be considered as tertiary monoblocks. In the latter,the post is adapted to a lubricated post space and photoactivated to partially polymerize the composite[28]. The relined assembly is then removed, and optimally polymerized prior to reinsertion for bonding with a resin cement. The efficacies of these systems have not been thoroughly investigated. In the Anatomic Post system, the resin cement layer was significantly reduced except for the apical portion of the post space in which no relining composite was included by the manufacturer. [29]

Active GP:

In Active GP (Brasseler USA, Svannah, GA) is marketed as a Monoblock system by using conventional gutta-percha cones that are surface coated with glass-ionomer fillers using a proprietary technique.[30]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 [31]

Problems Associated In Bonding

Polymerisation of resin materials will lead to shrinkage, resulting in separation at the areas of weakest bond through which micro-organisms can ingress in to the root canals.[32] Configuration factor (C-factor) is the ratio of bonded to unbonded resin surface area which is supposed to be less than 3 for effective bonding.[33] However due to complex root canal configuration the ratio was found to be more than 1000 causing debonding at the dentin-sealer interface.[34] Time factor is also considered to be one of the problem associated with bond strength, as it gets deteriorated with time.[34] The apical one-third of the radicular dentine contains less number of dentinal tubules than the coronal dentine accounting for less resin tag formation during the adhesion procedure.[35] It has been reported that the hybrid layer favours the bond strength rather than resin tag formation.[36] As radicular dentine contains more intertubular dentine it results in more hybrid layer formation which is favourable for bonding.[37]

Sealability Of Monoblock Interfaces

Achieving a hermetic seal throughout the root canal system either chemically or micromechanically is necessary for the successful outcome. Probable causes of microleakage could be due to poor adhesion wettability, polymerization shrinkage, thermal stresses, occlusal loading and water sorption.[38]

Conclusion

Although the concept of creating mechanically homogenous units with root dentin is excellent in theory, accomplishing these “ideal monoblocks” in the root canal space is easier said than done .Beginning with dentin adhesive application, removing thick smear layers or attempts to infiltrate these smear layers with mild self-etching adhesives is not as predictably achieved inside a long narrow channel even with improved vision from a surgical microscope. Evaporating adhesive solvents andhydrogen-bonded water from hydrophilic adhesives is difficult even for crown dentin. [38,39] The Modulus of elasticity and sealing ability are the two controversies associated with the monoblocks which do not contribute for the root fortification.[40,41]

The concept of monoblock seems simpler in literature but is quite challenging to achieve clinically. The prerequisites of achieving monoblock states that modulus of elasticity of dentin should approximate with that of the monoblock used. This will lead to lower stress generation. Secondary and tertiary monoblocks have higher magnitude of stresses than primary monoblock and the complexities associated with these shrinkage and stress generation becomes higher as we move from primary to tertiary monoblock. Resilon creates better monoblock than MTA as pattern of distribution of stresses is similar to natural teeth. Polymerisation of resin causes shrinkage stresses causing gaps in the canal walls and due to the highly variable canal design, these stresses are almost unavoidable until nonshrinking resin are available. Only then the concept of monoblock can be seen as an ideal goal. [40,41]

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