

## Original Research

# Finite elemental stress analysis of Monoblocks in root canals: An observational study

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## ARTICLE INFO



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## ABSTRACT

**Background:** The present study was conducted for evaluating finite elemental stress analysis (FEA) of Monoblocks in root canals.

**Materials & methods:** Forty maxillary incisor FEA models representing different monoblocks using several materials were created as follows: (a) primary monoblock with Mineral Trioxide Aggregate; (b) secondary monoblock with sealer (MetaSEAL) and Resilon; (c) tertiary monoblock with EndoREZ; and (d) primary monoblock with polyethylene fibre post-core (Ribbond). AAt a 135° angle to the tooth's long axis, a 300 N force was applied from the crown's palatal surface. Except for the glass-fibre post, the study's materials were presumed to be homogeneous and isotropic; the von Mises criteria was employed to express the findings. A statistical analysis was performed after recording all the results in a Microsoft Excel document.

**Results:** Max von Mises stress values among specimens of Primary monoblock with Mineral Trioxide Aggregate group, Secondary monoblock with sealer (MetaSEAL) and Resilon group, Tertiary monoblock with EndoREZ group and Primary monoblock with polyethylene fibre post-core (Ribbond) group was 7.2°, 7.9°, 7.8° and 20.7° respectively. The places where force was applied had the highest strains. With more interfaces, both for the post-core systems and the sealers' monoblocks, the strains within the models grew.

**Conclusion:** As the number of adhesive contacts increased, so did the stresses within the roots. Stresses inside the tooth structure can be decreased by forming a main monoblock within the root canal using either an endodontic sealer or an adhesive post-core device.

## Introduction:

Thorough cleaning, shape, and three-dimensional obturation are essential to the success of root canal therapy. The root canal sealer and the core filling materials must form distinct surfaces known as a monoblock in order to achieve a hermetic seal. These interfaces are used to categorise monoblocks into primary, secondary, and tertiary monoblocks.<sup>1-3</sup>

The monoblock must have a sufficient binding strength and an elastic modulus that is comparable to dentin in order to meet the criteria. There are some questions about these monoblocks' capacity to fuse together in the root canal, which makes it difficult to guarantee a tight closure. These questions are related to differences

between the elastic modulus of resin-based obturating materials and dentin.<sup>4</sup> The term "Primary monoblock" refers to the single circumferential interface produced between the root canal wall and the obturating substance. Examples include Biogutta, Polyethylene Fiber Post-Core Systems, Hydron, and Mineral Trioxide Aggregate (MTA). The materials supporting fundamental monoblocks are easily manipulable, non-irritating, with adequate flexibility, and have the capacity to calcify even if they are unintentionally pulled out of the canal. MTA formed interfacial apatite deposits, resulting in an excellent seal, which strengthened the teeth.<sup>5-7</sup> Hence; the present study was conducted for evaluating finite elemental stress analysis of Monoblocks in root canals.

### Materials & methods:

The present study was conducted for evaluating finite elemental stress analysis of Monoblocks in root canals. Forty maxillary incisor FEA models representing different monoblocks using several materials were created as follows: (a) primary monoblock with Mineral Trioxide Aggregate; (b) secondary monoblock with sealer (MetaSEAL) and Resilon; (c) tertiary monoblock with EndoREZ; and (d) primary monoblock with polyethylene fibre post-core (Ribbond). At a 135° angle to the tooth's long axis, a 300 N force was applied from the crown's palatal surface. Except for the glass-fibre post, the study's materials were presumed to be homogeneous and isotropic; the von Mises criteria Was employed to express the findings. A statistical analysis

was performed after recording all the results in a Microsoft Excel document.

### Results:

Max von Mises stress values among specimens of Primary monoblock with Mineral Trioxide Aggregate group, Secondary monoblock with sealer (MetaSEAL) and Resilon group, Tertiary monoblock with EndoREZ group and Primary monoblock with polyethylene fibre post-core (Ribbond) group was 7.2°, 7.9°, 7.8° and 20.7° respectively. The places where force was applied had the highest strains. With more interfaces, both for the post-core systems and the sealers' monoblocks, the strains within the models grew.

Study groups	Elastic modulus	Poisson's ratio
Primary monoblock with Mineral Trioxide Aggregate	16- 32	0.358
Secondary monoblock with sealer (MetaSEAL) and Resilon	0.074-0.135	0.49
Tertiary monoblock with EndoREZ	0.068-0.158	0.56
Primary monoblock with polyethylene fibre post-core (Ribbond)	12.6	0.28

**Table 1: Elastic modulus and Poisson's ratio**

Study groups	Max	Sum
Primary monoblock with Mineral Trioxide Aggregate	7.2°	312.8 °
Secondary monoblock with sealer (MetaSEAL) and Resilon	7.9°	1543.7°
Tertiary monoblock with EndoREZ	7.8°	2684.3°
Primary monoblock with polyethylene fibre post-core (Ribbond)	20.7°	4965.8°

**Table 2: Von Mises stress values**

### Discussion:

While pulpitis and apical periodontitis respond well to root canal treatment (RCT), the 10-year failure rate was about 20%. The majority of these occurrences, along with improper mechanical debridement, bacterial

persistence in the canals and apex, poor obturation quality, over- and underextension of the root canal filling, and coronal leakage, can be blamed. Obturation of the root canal system may be necessary as the last stage in RCT to prevent the infiltration of microorganisms from outside the canal, encase the

remaining bacteria and their byproducts, and prevent fluid from serving as a source of nutrition for microorganisms from any source. An appropriate material for obturating canals should conform nicely to the rough edges of the prepared canal walls while maintaining its homogeneity and dimensions. There are other techniques to obturate the root canal system, but the technique that is most frequently recommended is the use of gutta-percha as the core obturation material in conjunction with a root canal sealer.<sup>7-10</sup> Hence; the present study was conducted for evaluating finite elemental stress analysis of Monoblocks in root canals.

Max von Mises stress values among specimens of Primary monoblock with Mineral Trioxide Aggregate group, Secondary monoblock with sealer (MetaSEAL) and Resilon group, Tertiary monoblock with EndoREZ group and Primary monoblock with polyethylene fibre post-core (Ribbond) group was 7.2°, 7.9°, 7.8° and 20.7° respectively. The places where force was applied had the highest strains. With more interfaces, both for the post-core systems and the sealers' monoblocks, the strains within the models grew. 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-hydroxyethyl methacrylate (HEMA) containing root filling material, Hydron (hydron Technologies, Inc., Pompano Beach, Florida, USA) was marketed commercially for en masse filling of root canals. 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. 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 (Gillespie WT et al, Koch K et al, Doyle MD et al).<sup>10-12</sup> Zarone F et al evaluated different restoring configurations of a crownless maxillary central incisor. A 3D FE model of a maxillary central incisor is presented. An arbitrary static force of 10 N was applied with an angulation of 125 degrees to the tooth longitudinal axis at level of the palatal surface of the crown. High modulus materials used for the restoration strongly alter the natural biomechanical behavior of the tooth. Critical areas of high stress concentration are the restoration-cement-dentin interface both in the root canal

and on the buccal and lingual aspects of the tooth-restoration interface. Materials with mechanical properties underposable to that of dentin or enamel improve the biomechanical behavior of the restored tooth reducing the areas of high stress concentration. The use of endocrown restorations present the advantage of reducing the interfaces of the restorative system.<sup>13</sup>

### Conclusion:

As the number of adhesive contacts increased, so did the stresses within the roots. Stresses inside the tooth structure can be decreased by forming a main monoblock within the root canal using either an endodontic sealer or an adhesive post-core device.

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