Effect of MTAD, Qmix 2 in 1 and Sodium Hypochlorite on Modulus of Elasticity and Flexural Strength of Dentin

ABSTRACT

Aim The aim of the present study was to evaluate and compare the effect of MTAD, Qmix 2 in 1 and sodium hypochlorite on flexural strength and elastic modulus of dentin.

Materials and Methods In this study, 40 freshly extracted human molars were selected and cut into plano-parallel dentin bars of dimensions of 1 × 7 mm. Then, the samples were randomly divided into four groups; one control i.e. saline group and three test groups i.e. 3% NaOCl, 10% MTAD and Qmix 2 in 1. The samples were stored in irrigants for 2 h followed by rinsing with distilled water and solution was changed every 15 min to prevent saturation by reaction products. At the completion of treatment, the bars were tested for modulus of elasticity and flexural strength using three-point bending test in Universal Testing Machine at a cross-head speed of 1 mm/min.

Results There was no significant difference in flexural strength and modulus of elasticity between the dentin bars exposed to MTAD, NaOCl and Qmix when applied according to the clinical protocol. But there was significant difference between control group and experimental groups.

Conclusion When irrigants used as prescribed for clinical use do not affect the physical properties of the dentin.

KEYWORDS MTAD, QMix 2 in 1, sodium hypochlorite, endodontic irrigants

INTRODUCTION

The success of endodontic treatment depends on the eradication of microbes from the root-canal system and prevention of re-infection. Irrigants facilitate the removal of microorganisms, tissue remnants and dentin chips from the root canal and also prevent packing of the hard and soft tissue in the apical root canal and extrusion into the periradicular area. Sodium hypochlorite (NaOCl) is the most popular irrigating solution. NaOCl is commonly used in concentrations between 0.5% and 6%. It is a potent antimicrobial agent, killing most bacteria instantly on direct contact. It also effectively dissolves pulpal remnants and collagen, the main organic components of dentin.

QMix 2 in 1 (Dentsply Tulsa Dental, Tulsa, OK) is a new endodontic irrigation solution for smear layer removal with antibacterial activity. It contains EDTA, CHX, a detergent, and water. The chemical design of QMix prevents the formation of precipitate, which occurs when CHX is combined with EDTA or NaOCl.

MTAD (a mixture of doxycycline, citric acid, and a detergent [Tween 80]; Dentsply, Tulsa, OK) has been the focus of attention as an alternative root canal irrigant. MTAD, introduced by Torabinejad and Johnson at the Loma Linda University in 2003, is an aqueous solution of 3% doxycycline, a broad-spectrum antibiotic; 4.25% citric acid, a demineralizing agent; and 0.5% polysorbate 80 detergent (Tween 80).

Apart from the beneficial effects of endodontic irrigants, they have detrimental effects on root canal dentin. Endodontic irrigants result in a significant decrease in organic as well as inorganic content of root canal dentin. NaOCl is the most widely used root-canal irrigant. It significantly...
lowers the flexural strength and modulus of elasticity of dentin bars after a 2-h exposure, thereby possibly contributing to the weakening of root canal-treated teeth. So in addition to antibacterial effect and biocompatibility, an ideal irrigant should have minimal effect on the physical properties of the tooth. The aim of the present study was to evaluate and compare the effect of MTAD, Qmix 2 in 1 and sodium hypochlorite on flexural strength and elastic modulus of dentin.

MATERIALS AND METHODS

16 freshly extracted human molars were selected for this study. Plano-parallel dentin bars were sectioned using diamond disc in 1-mm width with 7 mm of length. Dentin bars were randomly divided into four groups as below.

- Group 1: Saline
- Group 2: NaOCl
- Group 3: MTAD
- Group 4: QMix 2 in 1

Dentin bars were stored in respective irrigants for 2-hrs and solution was changed every 15 min to prevent saturation by reaction products. At the completion of treatment, the bars were rinsed with copious amounts of deionized water. Afterwards modulus of elasticity and flexural strength using three-point bending test was checked.

MODULUS OF ELASTICITY AND FLEXURAL STRENGTH EVALUATION

Three-point flexural test

The specimens were tested on a three-point bend testing apparatus using an MTS Universal Testing Machine at a cross-head speed of 1 mm/min. The load required to fracture the specimens was recorded and expressed in MPa, and the mode of fracture was recorded as complete or incomplete fracture.

The flexural strength in MPa was calculated from the following equation

\[
\text{Stress} = \frac{3 \times \text{Load} \times \text{Length}}{2 \times \text{Width} \times \text{Thickness}^2}
\]

The modulus of elasticity in MPa was calculated from the following equation

\[
\text{Deformation} = \frac{\text{Load} \times \text{Length}^4}{4 \times \text{Elastic Modulus} \times \text{Width} \times \text{Thickness}^3}
\]

RESULTS

The means and standard deviations for flexural strength and modulus of elasticity are listed in Table 2. Control group i.e. saline group showed the highest flexural strength and modulus of elasticity followed by 3% NaOCl group, MTAD group and least was shown by Qmix 2 in 1 group.

DISCUSSION

Dentin is composed of inorganic components of hard dental tissues, in which calcium and phosphorus are distributed in the form of hydroxyapatite crystals. The Ca/P ratio in hydroxyapatite is approximately 1.67, and it depends on many factors such as level of mineralization, type of crystals, age of tissue and anatomical site.

Surface treatment of dentin with different agents may cause alterations in the chemical and structural composition of dentin, which in turn may change its permeability and solubility characteristics and subsequently loss of Ca/P ratio of root dentin resulting in an impact on the microhardness.

In this study, a 2-h exposure time was chosen for the “maximum time” which corresponds to the maximum time that tooth would be exposed to an irrigant during multi-visit endodontic treatment.

NaOCl is one of the most widely used root-canal irrigants significantly lowers the flexural strength and modulus of elasticity of dentin bars after a 2-h exposure, thereby possibly contributing to the weakening of root canal-treated teeth if used at higher concentration. But in this study NaOCl doesn’t lower the flexural strength and modulus of elasticity as concentration used was 3%.

Indigenous solution of MTAD was prepared with 0.05% Doxycycline, 10% citric acid and 10% Tween 80 at a ratio of 2:2:1. This ratio of 2:2:1 has been chosen

<table>
<thead>
<tr>
<th>Groups</th>
<th>Flexural strength</th>
<th>Modulus of elasticity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Saline (control)</td>
<td>154.203 ± 44.34</td>
<td>8.046 ± 1.14</td>
</tr>
<tr>
<td>MTAD</td>
<td>101.675 ± 20.36</td>
<td>2.343 ± 0.78</td>
</tr>
<tr>
<td>3% NaOCl</td>
<td>124.513 ± 44.54</td>
<td>7.520 ± 2.21</td>
</tr>
<tr>
<td>Qmix 2 in 1</td>
<td>105.824 ± 26.04</td>
<td>3.427 ± 1.01</td>
</tr>
</tbody>
</table>

Table 2

<table>
<thead>
<tr>
<th>Groups</th>
<th>Flexural strength</th>
<th>Modulus of elasticity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control group</td>
<td>Group I</td>
<td>Group II</td>
</tr>
<tr>
<td>Normal saline</td>
<td>30 ml of 3% sodium hypochlorite</td>
<td>10% MTAD</td>
</tr>
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depending on the importance of the role played by each ingredient. Dentinal bars treated with MTAD showed reduction of flexural strength and modulus of elasticity was statistically significant from the saline-control group and the majority of specimens exhibited incomplete fracture on incremental loading. This may due to the presence of citric acid in the MTAD which results in decrease in inorganic component of dentin. Qmix group significantly lowers the flexural strength from the control group. It can be explained due to the chelating effect of EDTA present in Qmix which leads to decrease in Ca/P ratio.

CONCLUSION

Within the limitations of this study, it was observed that when irrigants used according to the prescribed use they do not have much adverse effects on the tooth structure. So irrigants should be used judiciously.

REFERENCES