Comparison of Spreader Penetration during lateral compaction of 0.02 tapered Gutta-Percha Master Cones with Stainless steel and Nickel Titanium finger spreader

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Abstract

Aim: To compare the initial penetration depth of Stainless Steel and Nickel Titanium spreaders during lateral condensation of 0.02 tapered gutta-percha master cones.

Materials and Methods: 30 human extracted single-rooted and single canal teeth were selected. The crowns were removed and the canals were prepared using the hybrid step-back technique. Patency of the apical foramen as were maintained. The teeth were divided into 2 experimental groups of 15 teeth each. 0.02 tapered gutta-percha were inserted in the root canals of the first and second groups, respectively. A Stainless steel and Nickel Titanium spreader was then placed next to the master cone into two different groups and a digital scale was used to measure the force that was applied during spreader placement. An apical force of 1.5kg was employed to place the spreaders. The penetration depth was measured, subtracted from the working length, and recorded. Statistical analysis was then performed using t-test.

Results: The mean spreader penetration depth, recorded as distance from working length, was 0.93 mm when using stainless steel spreader and 1.87 mm following insertion of nickel-titanium spreader. The difference between the two penetration depths was statistically significant (P<0.05). Conclusion: The results of this study showed that the spreader penetration using stainless steel spreader was significantly larger than the nickel-titanium spreader.

Key Words: Gutta-percha; Master cone; Spreader

Introduction:

Successful endodontic therapy requires debridement and sealing of the root canal system to prevent microleakage. This is accomplished by maintaining an aseptic field, mechanical instrumentation, chemical irrigation, intracanal medication when indicated and obturation of the root canal including placement of a coronal restoration. Obturation prevents leakage of micro-organisms and their by-products penetrating the periradicular tissues, therefore it is significant for successful endodontic therapy. One of the most commonly used methods for root canal obturation is lateral compaction (condensation) of gutta-percha. Conventional lateral condensation (CLC) of gutta-percha has long been the standard against which other methods of canal obturation have been judged. The basic technique, lateral compaction of a fitted gutta-percha master cone by a tapered spreader to make room for additional accessory gutta-percha cones, was described in 1930. Stainless steel does not readily corrode, rust or stain with water as ordinary steel does, but despite the name it is not strongly and remain attached to the surface. The nickel–titanium alloys used in root canal treatment contain approximately 56% (wt) nickel and 44% (wt) titanium. In some NiTi alloys, a small percentage (<2% wt) of nickel can be substituted by cobalt. The resultant combination is a one-to-one atomic ratio (equiatomic) of the major components and, as with other metallic systems, the alloy can exist in various crystallographic forms. The generic term for these alloys is 55- Nitinol; they have an inherent ability to alter their type of atomic bonding which causes unique and significant changes in the mechanical
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Properties and crystallographic arrangement of the alloy. These changes occur as a function of temperature and stress. The two unique features that are of relevance to clinical dentistry occur as a result of the austenite to that when it is cooled through a critical transformation temperature range (TTR), the alloy shows dramatic changes in its modulus of elasticity (stiffness), yield strength and electric resistivity as a result of changes in electron bonding. By reducing or cooling the temperature through this range, there is a change in the crystal structure which is known as the martensitic transformation; the amount of this transformation is a function of the start (Ms) and finish (Mf) temperature. The phenomenon causes a change in the physical properties of the alloy (Wang et al. 1972) and gives rise to the shape memory characteristic.9,10

When employing this technique, it has been shown that the apical seal is best when the spreader can be placed close to the working length.11,12 Gutta-percha is the most popular core material used for obturation and is available in conventional and standardized sizes. The conventional gutta-percha number refers to the dimensions of the tip and body. The size of standardized cones is based on similar size and taper standards as for endodontic files.13 Manufacturers now supply gutta-percha cones in tapers matching the larger taper instruments (0.04, 0.06, 0.08).13 The use of the lateral condensation technique would involve the fitting of a standardized gutta-percha master cone with an apical to coronal taper of 0.02 mm/mm. This is followed by lateral condensation with a spreader and the addition of numerous accessory gutta-percha cones in an attempt to obliterate the space between the master cone and the walls of the prepared canal space.14 It seems that filling the prepared canal using a master cone with a larger tapering, may be clinically efficient and radiographically acceptable. There are only a few studies on the quality of obturation using larger tapered gutta-percha master cones.15-18

The purpose of this in vitro study was to compare the initial penetration depth of Stainless Steel and Nickel Titanium spreaders during lateral condensation of 0.02 tapered gutta-percha master cones.

Materials and Methods:
In this study 30 extracted human teeth with single, straight root canals were used. All specimens were stored in isotonic normal saline after extraction. Before preparation, the samples were treated with 5.25% sodium hypochlorite for 24 hours to disinfect and eliminate surface soft tissues. A length of 17 mm was marked on the teeth and the rest of the coronal portion was removed using a high speed disk. Working lengths were established by inserting a size 15 K-File (Mani, Japan) into the canal until visible at the apical foramen and was confirmed on radiovisioigraph (RVG) (Fig.1A). And subtracting 1mm from this length. 19 The root canals were prepared using the hybrid step-back technique. Master apical file was a size 30 K-file in all root canals. The coronal half of the root canals were preflared with Gates Glidden drills numbers 2 and 3 (Dentsply, Maillefer, Switzerland). The canals were flared using the step back technique to number 70 k-file and were copiously irrigated with 2ml of normal saline between each file. The patency of the apical foramen was confirmed with a size 10 K-File. To secure the samples in a vertical orientation, each tooth was embedded in acrylic blocks and periodontal ligaments were simulated using putty material around the tooth. (Fig.1B). The acrylic blocks, with the tooth secured, was placed on a digital scale (Universal Testing Machine) to measure the force used during spreader placement. The Apexit sealer (Ivoclar, Germany) was mixed according to the manufacturer’s instructions and was applied to the walls of the canal with a size 25 K-File.

The teeth were randomly divided into two groups of 15 teeth:
Group-1: Stainless Steel spreader group,
Group-2: Nickel-Titanium (Ni-Ti) spreader group.

Size 30, 0.02 tapered gutta-percha cones were used as master cones in either group which was confirmed on radiovisioigraph (RVG) (Fig.1C). A size 25, stainless-steel (Mani, Japan) and nickel-titanium (VDW<Germany), finger spreader was placed at the same entry point (the buccal or lingual wall) in each root. An apical pressure was then applied and increased without rotation until 1.5kg (±0.05kg) registered on the scale. The rubber stop was placed flush with the occlusal reference surface. The spreader was removed and measured. Measurements were recorded as working length minus the measured length. The spreader penetration in the canal with stainless steel and nickel-titanium spreader is shown in Figures 1D and E. The collected data were analyzed using t-test.

Fig. 1 (A): working length determination.
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Results:

The mean (standard deviations) depths of spreader penetration, recorded as distance from working length, when using stainless steel and nickel-titanium spreader was 0.93 mm and 1.87 mm, respectively. The minimum depths of penetration in both groups were zero however the maximum depths of penetrations were 2mm and 3.5 mm in stainless steel and nickel-titanium spreader groups respectively. The mean depths of spreader penetration when employing stainless steel was larger than nickel-titanium spreader (P<0.05).

Table 1: The comparison of Length of root canal, Length of spreader penetration and difference in Length (Root canal – Spreader penetration) between two spreaders.

<table>
<thead>
<tr>
<th>Length (mm)</th>
<th>Group A (SS Spreader) (n = 15)</th>
<th>Group B (Niti Spreader) (n = 15)</th>
<th>P-values (Group A v/s Group B)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Length of Root canal</td>
<td>16.5 ± 0.33</td>
<td>16.5 ± 0.35</td>
<td>0.790 (Non-Significant)</td>
</tr>
<tr>
<td>Length of Spreader penetration</td>
<td>15.6 ± 0.65</td>
<td>14.7 ± 1.41</td>
<td>0.033 (Significant)</td>
</tr>
<tr>
<td>Difference in Length (Root canal</td>
<td>0.93 ± 0.73</td>
<td>1.87 ± 1.32</td>
<td>0.023 (Significant)</td>
</tr>
<tr>
<td>– Spreader penetration)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Values are Mean ± Standard Deviation. P-values are obtained using independent sample’t’ test. P-value<0.05 is considered to be statistically significant.
Discussion:
The objective of the present study was to compare the penetrating ability of spreaders during lateral condensation with stainless steel and nickel-titanium spreader. Data obtained from the present study showed that the depth of spreader penetration with the stainless steel was greater than nickel-titanium spreader. Extracted teeth were randomly divided between two groups, as a result the anatomical difference in specimens’ size, shape and apical diameters might be balanced. In order to enhance the reproducibility of the investigation, the
teeth were prepared by one operator who used the hybrid step-back technique. Therefore, tapering of the prepared canals was about 0.05mm/mm which allowed placement of 0.02 tapered gutta-percha master cones in the canals.

Finger spreaders were used in the current study, due to the fact that they can provide better tactile sensation and are less likely to induce root fractures as compared to hand spreaders. 20, 21 Spreaders made from nickel-titanium (NiTi) are available and deliver increased flexibility, reduced stress, and deeper penetration in curved canals compared to stainless-steel spreaders.22,23 However, there is no significant difference in stress induction between stainless-steel spreaders and nickel titanium spreaders, in straight canals. 25 It can be assumed that the less flexible stainless steel spreaders would penetrate better in a straight canal.24 Teeth with straight root canals and stainless-steel (SS) nickel-titanium (NiTi) spreaders were used in the present study. Application of apical pressure on spreaders to gain close proximity to the apex may lead to vertical root fractures. 25 Spreader loads from 1.5 kg to 7.2 have been shown to produce fractures. 26 Harvey et al. 27 reported that the average force used by endodontists during lateral compaction of gutta-percha was between 1.0 and 3.0 kg. In this study a compaction force of 1.5 kg was applied during the use of spreaders.

Wilson and Baumgartner 15 demonstrated that the depth of penetration for both NiTi and SS spreaders was significantly less when using 0.04 versus 0.02 tapered master cones. A similar result has been reported by Nielsen and Baumgartner in 2006. 16 They compared spreader penetration in root canals using 0.02 or 0.04 tapered gutta-percha cones and using 0.02 or 0.04 tapered resilon cones. They showed in both gutta-percha and resilon cones, spreaders penetrate deeper with 0.02 tapered cones compared to 0.04 tapered cones. Because lateral condensation, unlike vertical condensation, does not create a homogeneous mass of gutta-percha, pools of sealer may be trapped in the filling mass as accessory cones are compacted against each other. Filling with a master cone using a larger taper may be advantageous in that a larger and more uniform mass of gutta-percha is introduced that potentially has less sealer entrapped in the filling mass. However, because of the close approximation of the gutta-percha cone to the prepared canal walls, a disadvantage results from the inability of a spreader to predictably penetrate to within 1 to 2 mm of the working length. This causes inadequate compaction of the master cone (using step back technique) causing a potential deficiency in the seal of the canal. Further investigation is suggested to evaluate the quality of the seal produced.

Conclusion:
Considering limitations of present study, the use of stainless steel spreader could provide better penetration as close to the apex to provide better apical seal compare to nickel-titanium spreader in straight root canals.

References: