A comparative evaluation of two root canal instrumentation techniques for preparation of oval shaped root canals using cone beam computed tomography-an in vitro study

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Abstract:
Aim & Objective: This study aimed to compare the efficacy of two instrumentation techniques: Anatomic Endodontic Technology (AET) & Anthogyr with K3 NiTi instruments in oval shaped root canals.
Materials and methods: Two groups each of 15 extracted human mandibular premolars with oval-shaped root canals were used. In group 1, canal preparation was carried out using Anatomic Endodontic Technology and in group 2, Anthogyr system both using K3 Nickel Titanium (NiTi) instruments. Irrigation was done using 3% sodium hypochlorite. Pre and post instrumentation images obtained from cone beam computed tomography were compared using Kodak dental software to assess cross sectional canal shape.
Results: No significant difference was found between the two techniques with regard to preparation of oval shaped root canals.
Conclusion: Anatomic Endodontic Technology (AET) did not perform better than rotary Anthogyr in oval-shaped root canals.

Keywords: Anatomic endodontic technology, Anthogyr, K3 Rotary instruments, Reciprocating motion, Oval canals, Root canal preparation, Cone beam computed tomography.

Introduction
Shaping and cleaning of root canal system is considered as a paramount in obtaining success of root canal therapy. There are two primary objectives for shaping and cleaning. First, is removal of pulp tissue, bacteria and necrotic debris from root canal reducing critical count of microorganisms. Second, is to shape the canal to adequate taper to promote irrigation and placement of obturating materials to obtain a three dimensional seal, thus preventing bacterial microleakage. As root canal system has complex anatomy, complete debridement seems to be an impossible task.¹ Depending on the variation in canal anatomy, shaping outcomes of root canals may vary. Shaping of teeth with oval shaped canals has been found to be difficult and un-instrumented recesses may remain.²³ Unprepared lingual and buccal extensions were observed with both NiTi rotary instruments and hand instrumentation with balanced force technique.⁴⁵ Reciprocating systems with NiTi instruments were introduced to improve canal preparation and maintain the original shape as an oscillating file moves with short amplitudes in all direction compared to continuous rotation and is expected to touch all surfaces of a canal.⁶ Anatomic Endodontic Technology (AET) (Ultradent Products Inc, South Jordan, UT) was introduced to maintain natural shape of root canal during preparation. To the best knowledge of the authors of the current study, there is no published data on the comparison of reciprocating and continuous rotation with K3 NiTi instrument.

So, the study aimed to evaluate preparation of oval shaped root canal using reciprocating or continuous rotating NiTi system by cone beam computed tomography. The study hypothesis was that reciprocating system used with a NiTi instrument will prepare oval canals better then rotary systems.

Materials and Methodology
A total of 30 freshly extracted permanent mandibular premolar with single oval shaped canal and fully formed apices were selected for the study and were stored in physiologic saline until they were used. All the teeth that were selected had less then 15 degrees of deviation from the long axis as using teeth with straight canal reduced the difference in action between the two instrumentation techniques.⁷ Radiographs were obtained to determine oval-shape root canal and included in this study only if buccal-lingual to mesial distal dimension had a ratio of atleast 2:1.⁹ Access cavity preparation was done using a water cooled diamond bur in a high speed hand piece and working length was confirmed by introducing a 15 size K file into the canal until the tip of the file was just visible at the apical foramen and then reducing 1mm from that length for standardization. Teeth were divided into two groups of 15 teeth each on random basis. The teeth were mounted in clear acrylic and were placed on a plastic plate which served as a container for teeth. The
plastic plate was placed in cone beam computed tomography machine (Kodak 9000) and aligned so that long axis of the roots was perpendicular to beam. The teeth were then scanned using 0.2 mm thickness slices with table increments of 1 mm. The slice data from scan were archived on the magnetic computer tape for storage.

In Group 1, the canals were prepared using AET with K3 rotary instruments in crown down manner. Each file was examined before and after use for any visual defects under operating microscope at a magnification of x2.5 (Carl zeiss). Each set of files were used to prepare 5 canals only. Orifice was prepared using 0.12/25 K3 followed by 0.10/25 and 0.08/25 for preparation of coronal and middle third, 0.06/25 was used for preparation of apical third. After each instrument canals were irrigated with 5ml of 3% sodium hypochlorite. In Group 2, the preparation was done similar to Group1 using Anthogyr with K3 instruments.

**Evaluation:**

After instrumentation, all teeth were again scanned similar to pre-operative scanning position and specification. The slice data were stored, and pre and post instrumentation scanned images were compared and analyzed using Kodak dental software. As the diameter of a root canal is not constant from the orifice to the apex, the roots were evaluated at 3, 6 and 9 mm from the apex, respectively, allowing inspection of all thirds of a root canal.

Canal shaping was determined by measuring shortest distance from the inner dentinal wall of uninstrumented canal to external surface of the tooth in both buccal and lingual directions and then compared this with instrumented images.

**Canal shaping = [(x1-x2)-(y1-y2)]**

- x1=shortest distance from the inner dentinal wall of uninstrumented canal to external surface of the tooth in buccal direction.
- x2=shortest distance from the inner dentinal wall of instrumented canal to external surface of the tooth in buccal direction.
- y1=shortest distance from the inner dentinal wall of uninstrumented canal to external surface of the tooth in lingual direction.
- y2=shortest distance from the inner dentinal wall of instrumented canal to external surface of the tooth in lingual direction.

Value of ‘0’ obtained from this formula indicates there is no untouched area and buccal and lingual walls of the canal are uniformly prepared. Any deviation from this value suggested uneven or non uniform canal preparation. It was taken as ‘1’ for statistical purpose.

Statistical analysis was performed to check percentage of uniformly prepared canals using Chi-square test. Statistical significance was considered as p < 0.05.

<table>
<thead>
<tr>
<th>Sections</th>
<th>Group 1</th>
<th>%</th>
<th>Group 2</th>
<th>%</th>
<th>Total</th>
<th>%</th>
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<tbody>
<tr>
<td><strong>Coronal 3rd</strong></td>
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<tr>
<td>Score 0</td>
<td>9</td>
<td>60.00</td>
<td>6</td>
<td>40.00</td>
<td>15</td>
<td>50.00</td>
</tr>
<tr>
<td>Score 1</td>
<td>6</td>
<td>40.00</td>
<td>9</td>
<td>60.00</td>
<td>15</td>
<td>50.00</td>
</tr>
<tr>
<td>Chi-square=1.2001 df=1 p=0.2733</td>
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</tbody>
</table>

| **Middle 3rd** |         |       |         |       |       |       |
| Score 0        | 12      | 80.00 | 10      | 66.67 | 22    | 73.33 |
| Score 1        | 3       | 20.00 | 5       | 33.33 | 8     | 26.67 |
| Chi-square= 0.6822 df=1 p=0.4089 |

| **Apical 3rd** |         |       |         |       |       |       |
| Score 0        | 7       | 46.67 | 10      | 66.67 | 17    | 56.67 |
| Score 1        | 8       | 53.33 | 5       | 33.33 | 13    | 43.33 |
| Chi-square=1.2227 df=1 p=0.26903 |

| Total          | 15      | 100.00| 15      | 100.00| 30    | 100.00|
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AET (GROUP 1)

Pre Instrumentation

Post Instrumentation

1.7  2.0
CORONAL

1.7  2.0

1.7  1.9
MIDDLE

1.6  1.8

1.2  1.4
APICAL

1.1  1.3
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ANTHOGYR (GROUP 2)

Pre Instrumentation

Post Instrumentation

CORONAL

1.8
1.5

1.7
1.4

MIDDLE

1.5
1.4

1.4
1.3

APICAL

1.6
1.5

1.5
1.4
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Results
In Group 1, the percentage of teeth showing uniform preparation was 60% in coronal third (9 out of 15), 80% in middle third (12 out of 15) and 46.67% in apical third (7 out of 15). In Group 2, 40% (6 out of 15) of the teeth showed uniform preparation in coronal third, while in middle and apical third it was 66.67% (10 out of 15).

Both the groups showed uniform shaping in the middle third, with Group 1 slightly outperforming Group 2, although there was no statistically significant difference between the two groups (p>0.05).

Discussion
Present study was done to examine whether the lingual and buccal extensions of oval root canals could be prepared completely with NiTi instruments using different principles of instrumentation—reciprocation (oscillating movement) and continuous rotation. The hypothesis given was that an oscillating system could be an improvement over a rotary system in preparation of oval shaped root canals.

Rotary instruments regardless of their type and form if used in a simple linear filing motion produce a preparation with a round outline, which in majority of the cases do not coincide with the cross sectional outline of the root canal. Similarly, manual instrumentation techniques, such as the balanced force technique usually implement rotary movement of files, which tends to create a round root canal preparation. Therefore, when the root canal outline deviates from a round form incomplete shaping is observed. When viewed cross sectionally apart from round canals, oval shaped canals are fairly common deviation and difficulties have been noted in cleaning these oval canals. Numerous instruments and preparation techniques have been recommended to enable the preparation of oval root canals, circumferential filing with hand and rotary instruments being the most common.

Nevertheless, incomplete preparations have been observed in most of the studies. Recesses in oval canals may not be included in a round preparation created by rotation of instruments, and thus they remain unprepared.

Reciprocating systems were introduced to obtain more predictable canal preparation as compared to rotary systems which were found to leave unprepared recesses in oval canals. The reason for this presumption is that, it would be more difficult to keep a rotating instrument in place particularly in the middle part of the root canal compared to an oscillating file which moves in all directions with a short amplitude. A mechanical reciprocating movement has advantage as it somewhat mimics manual movement and reduces the various risks associated with continuously rotating a file through canal curvatures.

The first system investigated in this study was the oscillating AET, which claimed to permit a perimetric or circumferential preparation of coronal and middle thirds of oval root canals. Various studies done earlier have compared reciprocating AET system with continuous rotation system in oval canals and have found mixed results. AET system recommends the use of stainless steel instruments for complete preparation till date however, there has been no investigation made regarding use of AET with NiTi instruments in preparation of oval canals. According to manufacturer, any NiTi file can be used with the AET handpiece, the degree of efficiency varies, greatly depending on the geometry and flute design of the respective file. NiTi instruments have a two to three times higher elastic flexibility (‘super elasticity’) and a superior resistance to torsional fracture than stainless steel instruments, which makes these instruments useful for preparation in oval canals but it seems questionable whether highly flexible NiTi instruments allow controlled preparation of such extensions. This hybridization of NiTi oscillating/reciprocating allows NiTi instruments to be used safely in any portion of the root canal system. Further, 30 degree oscillation (reciprocation) greatly reduces the risk of file separation due to torsion and flexural stresses. Though complete preparation with stainless steel instruments includes a high risk of perforating or significantly weakening the root and pushing debris beyond the apex.

The second system used here was continuous rotation Anthogyr torque control contra-angle handpiece. Anthogyr is a system with adjustable torque and automatic declutching, which aids in preventing instrument separation and can be used with all rotary NiTi instruments. In the present study, K3 NiTi instruments were used in both groups. K3 NiTi rotary instruments were introduced to facilitate efficient and safe root canal preparation by SybronEndo (Orange, CA, USA). K3 NiTi instrument which features an asymmetrical cross section was chosen as it has slightly positive rake angle, variable helical flute angle and radial land. Radial land centralizes the instrument within the canal. Studies have shown that it produces least transportation compared to other NiTi systems. It improves the resistance to torsion stress and also centralizes the instrument in the canal.

Peripheral blade relief was designed to reduce friction and facilitate smoother operation. It also helps to control the depth of cut. This aids in protecting the instrument from over-engagement, and separation. The third radial land was introduced into this system to prevent the instrument from threading itself into the canal. This feature prevents "screwing..."
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References:


