

Comparative Evaluation Of Remaining Dentin Thickness After Root Canal Preparation Using Different Rotary Files In Single-Rooted Teeth With Cone-Beam Computed Tomography: An In-Vitro Study

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Abstract:

Background: The success of endodontics depends on a variety of factors, with three-dimensional obturation, careful canal shape, and appropriate cleaning being crucial. Among these, the amount of dentin left over after instrumentation has a direct impact on the tooth's existence and biomechanical durability.

Materials and Methods: Each group of 20 specimens was randomly assigned to one of three experimental groups. Group A - Protaper Gold, Group B - WaveOne Gold, Group C - VDW Rotate. Each group of 20 specimens was randomly assigned to one of three experimental groups. Group A- Protaper Gold, Group B - WaveOne Gold, Group C - VDW Rotate. By comparing the CBCT post-instrumentation scan acquired during biomechanical preparation with a CBCT pre-instrumentation scan taken at three different levels, the amount of dentin that remained after the root canal was ascertained: From the apex, 2, 5, and 8 mm.

Results: At 2 mm (apical third):- ProTaper Gold showed the greatest reduction in dentin thickness followed by WaveOne Gold. VDW Rotate demonstrated the least reduction, suggesting more conservative dentin removal. At 5 mm (middle third):- All systems exhibited comparable reduction, though WaveOne Gold showed slightly higher mean thickness indicating better dentin preservation compared to ProTaper Gold and VDW Rotate. At 8 mm (coronal third):- The maximum dentin removal was noted with ProTaper Gold, whereas WaveOne Gold and VDW Rotate retained more dentin.

Conclusion: All methods successfully prepared the canals within the constraints of this in-vitro investigation, although the degree of dentin removal differed depending on design and motion kinematics. ProTaper Gold showed the greatest dentin removal, especially at the coronal level, whereas VDW Rotate was the most conservative.

Key Word: Dentin thickness, ProTaper Gold, WaveOne Gold, VDW Rotate.

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I. Introduction

Three-dimensional obturation, disinfection, and canal preparation are the three primary elements influencing the results of endodontic treatment. For endodontic therapy to be successful, the root canals must be properly shaped and cleaned. [1] The root's ability to withstand fracture is directly impacted by the amount of dentin that remains after instrumentation. Since the majority of dentin is removed during canal instrumentation, maintaining the thickness of remaining dentin is essential to the durability and strength of an endodontically tooth treatment.[2] The design also makes it simpler to preserve the location and integrity of the apical anatomy and the canal in order to prepare the tooth for the appropriate filling. On the other hand, overshaping weakens the root by abnormally reducing the thickness of the remaining dentin.[3] Since the introduction of NiTi rotary instrumentation in the 1980s, endodontics are simpler and quicker than with manual instrumentation, and root canal shape has become more uniform and predictable.[4] Traditionally, endodontic instruments were made with hand files, which had disadvantages like breakage and stiffness. To overcome these limitations, nickel-titanium (NiTi) devices were developed.

However, excessive dentin removal continued to be a major problem in obtaining a suitable canal taper.[5] The residual dentin thickness serves as a mechanical threshold that should not be crossed when using

these instruments to increase the root canal diameter because doing so could cause the dentinal walls to become noticeably weaker.^[6] The challenge then becomes how to use any file technique to obtain a sufficient canal taper without severely cutting dentin. Making the right file system choice is crucial.^[7] This study is made more sophisticated by the use of cone-beam computed tomography (CBCT). As a very promising approach for researching the anatomy of root canals, CBCT has been highly recommended. It uses a detector and a cone-shaped x-ray beam to collect data in a cylindrical volume in one acquisition. The production of extremely precise cross-sectional and three-dimensional pictures with high resolution is one of CBCT's benefits; it is totally measurable and yields reliable, reproducible results.^[8] This study aimed to determine the effectiveness of three different file systems in relation to the amount of dentin that remained. The file systems used in this study were Protaper Gold, Waveone Gold, and VDW Rotate.

II. Material And Methods

Inclusion criteria:

1. No internal or external root resorption
2. Closed Apex

Exclusion criteria:

1. Root resorption
2. Major root angulation
3. Open Apex

Methodology:

A total of 60 non-carious, human single-rooted teeth were collected and disinfected in 3% NaOCl for half an hour, and then kept in a 0.9% normal saline solution. To verify the canal's patency, pre-operative radiographs were obtained. The teeth were then decoronated at the level of the CEJ using a diamond disc set on a straight handpiece operating slowly. Each group of 20 specimens was randomly assigned to one of three experimental groups. Group A- Protaper Gold, Group B - WaveOne Gold, Group C – VDW Rotate. A glide path was made using a no. 10K file, and the working length was obtained by measuring the canal length with a no. 15K file and subtracting 0.5 mm from the result. Each group's samples were then put on a sheet of modeling wax. After that, a baseline pre-instrumentation CBCT was acquired.

Group A (Protaper Gold):-

Protaper files follow this basic sequence: SX (orange), S1 (purple), S2 (white), F1 (yellow), and F2 (red). The file was rotated continuously clockwise using an endomotor at speed and torque of Sx and S1-300 rpm, and 5.10 torque, For S2 and F1-300 rpm and 1.50 torque. For F2-300 rpm and 3.10 torque as recommended by the manufacturer.

Group B (Wave One Gold):-

The reciprocating file system includes four sizes: primary red 21 mm with an ISO 25 tip and 7% taper for most of the canals, small yellow 21 mm with an ISO 20 tip and 7% taper for small canals, medium with an ISO 35 tip and 6% taper, and large black 25 mm with an ISO 45 tip and 5% taper for larger canals provided in four different single file sizes.

The file (n=20) was prepared using an endomotor in reciprocation mode. The endomotor was calibrated by the manufacturer. SMALL WaveOne Gold file no. 020.07 and PRIMARY WaveOne Gold file no. 025.07 were used. WaveOne Gold rotates 360° in three cycles (150° counterclockwise and 30° clockwise), with a speed of 350 rpm. The file had a 3mm range of movement. After every three succeeding movements, the file was removed, cleaned then rinsed with distilled water until the total working length was attained.

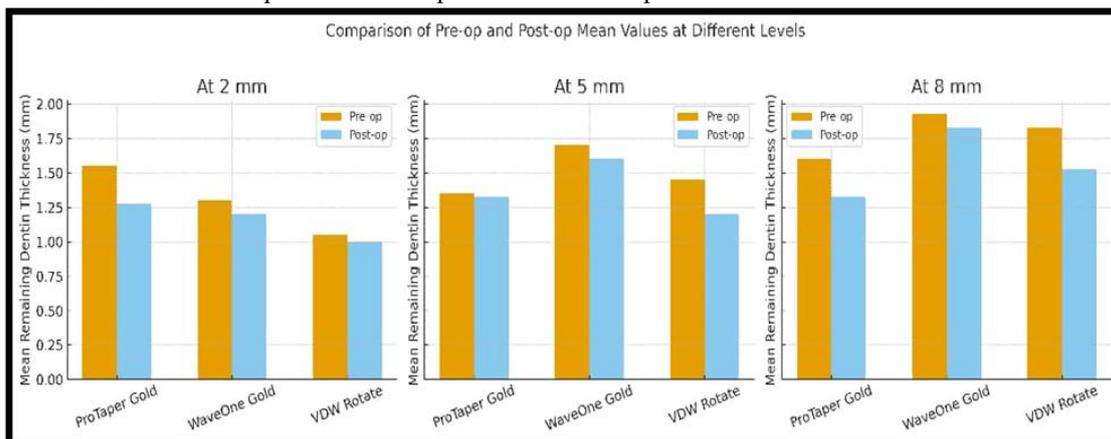
Group C (VDW Rotate):-

Root canals were prepared with Rotate 20.05 and 25.06 files taken up to the WL.

By comparing the CBCT post-instrumentation scan acquired during biomechanical preparation with a CBCT pre-instrumentation scan taken at three different levels, the amount of dentin that remained after the root canal was ascertained: From the apex, 2, 5, and 8 mm.

III. Result

Table no 1: Comparison of Pre-operative and Post-operative mean values at different levels



The remaining dentin thickness (RDT) was evaluated pre-operatively and post-operatively at three levels (2 mm, 5 mm, and 8 mm). At all levels, a reduction in dentin thickness was observed after instrumentation, indicating dentin removal during canal preparation.

At 2 mm (apical third):- ProTaper Gold showed the greatest reduction in dentin thickness followed by WaveOne Gold. VDW Rotate demonstrated the least reduction, suggesting more conservative dentin removal.

At 5 mm (middle third):- All systems exhibited comparable reduction, though WaveOne Gold showed slightly higher mean thickness indicating better dentin preservation compared to ProTaper Gold and VDW Rotate.

At 8 mm (coronal third):- The maximum dentin removal was noted with ProTaper Gold, whereas WaveOne Gold and VDW Rotate retained more dentin.

IV. Discussion

The current in vitro investigation used cone-beam computed tomography (CBCT) to examine the remaining dentin thickness (RDT) following root canal instrumentation with ProTaper Gold, WaveOne Gold, and VDW Rotate rotational systems at three levels (2 mm, 5 mm, and 8 mm).^[9]

Following biomechanical preparation, the results showed a consistent decrease in dentin thickness at all levels, with VDW Rotate exhibiting the least amount of dentin removal and ProTaper Gold exhibiting the greatest.^[10]

ProTaper Gold's progressively changing taper and convex triangular cross-section improve cutting efficiency and dentin removal, particularly in the coronal and middle thirds.^[11] These design features and instrumentation are responsible for the observed differences between the systems. Although the Gold alloy's increased flexibility lessens cycle fatigue, its vigorous cutting action increases dentin loss.^[12]

With its reciprocating motion and offset parallelogram cross-section, WaveOne Gold can only interact with dentin walls at two locations at a time.^[13] Compared to continuous rotary systems, this results in moderate dentin loss and improved root dentin preservation by reducing screwing-in and cutting aggressiveness.^[14]

VDW Rotate uses a controlled memory NiTi alloy and a constant taper with a modified S-shaped cross-section. These characteristics increase flexibility and decrease the region in contact with dentin, which leads to less dentin removal and more conservative canal shaping.^[15]

V. Conclusion

All methods successfully prepared the canals within the constraints of this in-vitro investigation, although the degree of dentin removal varied according to design and motion kinematics. ProTaper Gold showed the greatest dentin removal, especially at the coronal level, whereas VDW Rotate was the most conservative.

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