University J Dent Scie 2021; Vol. 7, Issue 3

An Ex-vivo Comparative Evaluation of Apical Debris and Irrigant Extrusion from Curved Canals Using Three Different Ni-Ti Instruments With Conventional Irrigation Methods.

Abstract ;

Aim: The present study aimed to compare and evaluate debris and irrigant extrusion from curved root canals using different Ni-Ti systems.

Materials and Method: 30 single rooted mandibular premolars were used in this study. Crown was decoronated, working length and initial apical diameter was established. 1.5% agar gel model was used in this study. Samples were assigned randomly into 3 groups (n = 10 teeth per group). Protaper Next, OneShape, NT GOLD files were used according to the manufacturers' instructions for canal instrumentation. Apically extruded debris and irrigant was computed by deducting the initial weight of the test apparatus without a tooth from its weight after the biomechanical preparation. Comparative analysis of the amount of apically extruded debris and irrigant for each of the instruments and the experimental models was performed.

Results: Statistically significant difference was found between the three experimental groups. (P <.05). Amid all the groups least extrusion was observed in the Protaper Next group when used in combination with conventional irrigation

Conclusion: All the instruments produced apically extruded debris and irrigant, but maximum was seen with One Shape among the experimental groups.

Keywords: Apically extruded debris and irrigant, NT Gold, Protaper Next, One Shape.

Introduction:

Endodontics is the branch of dentistry that deals with the etiology, diagnosis, prevention, and management of the "pulpal diseases.[1]" Success of the root canal treatment depends on a triad that is proper access cavity preparation, thorough cleaning and shaping, and 3-D filling of the canal space. Endodontic failure occurs when the treatment protocol followed is below standard. Endodontic failure is nothing but the persistence of symptoms, periapical pathology, and periapical radiolucency post-treatment. Endodontic failure may be attributed to various procedural errors like missed canals, under and over instrumentation, inadequate seal in root canal space, extrusion of debris, irrigants, and canal filling material in the "periapical region. [2]"

The incidence of flare-ups post-root canal treatment is reported to range from "1.4%– 16%.[3] Many factors that affect the inter appointment flare-ups and post-operative pain are like an error in working length determination, instrumentation techniques, apical debris extrusion, and over instrumentation. During biomechanical preparation of the root canal, dentin chips, pulp tissue, microorganism, and irrigants may be expelled into the periapical tissue. It has been proved that non-contaminated and contaminated debris when forced periapically can trigger an "inflammatory reaction.[4] Various studies have proved that the extrusion of debris may be affected by various reasons like different canal curvature, working length, difference in instrument kinematics, apical diameter, amount, and type of "irrigants used," number of "files," different instrumentation "technique," preflaring "coronal third," instrument design, irrigation system "used.

Access this article online	
Website: www.ujds.in	Quick Response Code
DOI: https://doi.org/10.21276/ujds.2021.7.3.14	

[1]POONAM SARDAR, [2]BALJEET SINGH HORA, [3]CHITRA GOHIL, [4]KRUTIKA BORKAR, [5]YADNESH DONDULKAR, [6]HARSH JAIN

1Department of Conservative Dentistry and Endodontics, AME Dental College and Hospital, Raichur

[2-6]Department of Conservative Dentistry and Endodontics, Chhattisgarh Dental College and Research Institute, Rajnandgaon, Chhattisgarh

Address for Correspondence: Dr. Baljeet Singh Hora Professor and Head, Department of Conservative Dentistry and Endodontics, Chhattisgarh Dental College and Research Institute, Rajnandgaon, Chhattisgarh

E-mail : drbaljeet69@yahoo.com

Received : 15 Sep., 2021, **Published :** 31 Dec., 2021

How to cite this article: Poonam Sardar, Baljeet Singh Hora, Dr. Chitra Gohil, Dr. Krutika Borkar, Dr. Yadnesh Dondulkar, & Dr. Harsh Jain. (2021). An Ex-vivo Comparative Evaluation of Apical Debris And Irrigant Extrusion From Curved Canals Using Three Different Ni-Ti Instruments With Conventional Irrigation Methods. UNIVERSITY JOURNAL OF DENTAL SCIENCES, 7(3).

” Hence it is highly essential to prevent debris extrusion through the selection of proper instruments and techniques.

Literature is evident that various researches have been done to minimize extrusion of debris and irrigant like advances in apex locators, modification in instrument design, use of side vented needle, and negative “irrigation system. [4]”

Studies have proved that various changes in the NiTi rotary design like Protaper Next (PTN), Mtwo, Oneshape, etc. have been done to minimize the debris extrusion.

However, no technology or method had been proved to be full proof in preventing the extrusion of debris and irrigant periapically, only the extent varies. Till date, no study had been found in research databases that evaluated the amount of apical extrusion of debris and irrigant comparing PTN, OneShape with NT Gold file. Like PTN and OneShape is also one of the continuous rotary file systems having a unique cross-section design. So, this study aimed to evaluate and compare the effect of three continuous rotary Ni-Ti instruments, using three different irrigation methods on apical extrusion of debris and irrigant in curved root canals.

Materials and Method:

Preparation of the teeth.

Thirty single rooted premolars indicated for extraction for orthodontic reasons were used in the study. Study duration from December 2020 to February 2021, at Chhattisgarh Dental college and research institute, Rajnandgaon. Fully formed roots of mandibular premolar having curvature angles from “10º to 20º,5,10” and independent apical foramina were selected for the study. The roots were sectioned at the cementoenamel junction with a diamond disk (to produce root specimens with a standardized size of 13 mm. Curvature angle was measured using ImageJ software (Fig 1).

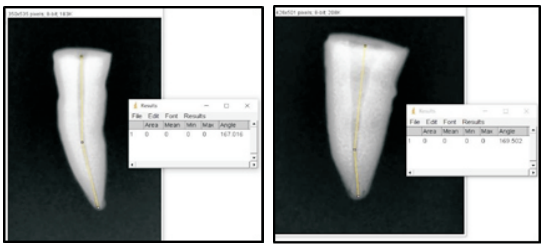

Figure 1: labio-lingual angulation with ImageJ software (a), mesio-distal angulation (b) with ImageJ software

The initial diameter of the apical foramen was established by inserting a #15 K-type file (Mani) so that it will penetrate the canal snugly, and its tip was visualized exiting the “apical foramen,5” and the working length was then set as 1 mm less than the observed length. This method was used to determine the working length of all the specimens. Samples were divided into three groups. In group A biomechanical preparation was done with Protaper

Next files, in group B it was done with OneShape file and in group C it was done with NT Gold file. Canals not fulfilling the criteria were excluded from the study and replaced with new specimens.

Test apparatus-

1.5% agar gel model was used in this study as described in previous studies to simulate “periapical tissue.6” The root specimen was wrapped with Teflon tape, leaving the apical foramen and coronal surface exposed and weighed using a microbalance (SHIMADZU AUW- 220D) [Fig 2 (a)] having an accuracy of 0.01 mg.

(a) (b) (c)

Figure 2: Pre and Post weight of the assembly

Agar solution was prepared in a 500 ml flask containing 100 ml of filtered distilled water and 1.5 g agar-agar powder (Weissmill) to achieve a 1.5% final concentration. Each tube was injected with 3 mL of 1.5% “agar gel.6” The root was pushed through the orifice, and a rubber dam sheet was placed to isolate the specimen, as done in a clinical “procedure.5” The tube was inverted to immerse the tooth in agar until the agar congealed [Fig 3 (a)].

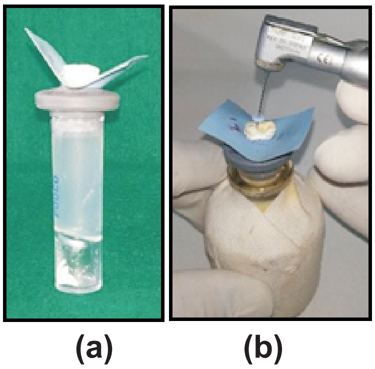

Figure 3: agar gel model (a) orifice enlargement with GG drill (b)

The apparatus was weighed [Fig 2 (b)], and the weight of the apparatus without the tooth was calculated. The apparatus was then placed inside an opaque bottle to prevent the operator from having any direct manual or visual contact with the tube during the procedure.

Procedure:

In all the groups, Coronal flaring in the canals was done using Gates-Glidden drills #4, #3, and #2 (Mani) "[Fig 3(b)].[8]" The root canals were initially flooded with 1ml 3% "NaOCl (Prime).[10,11]" Glide path was prepared by manual method with #8, #10, and #15 ISO 2% files (Mani) in a push and pull motion keep procedure standard for "all.[12]." The Endomotor (Endoking) was adjusted for each instrument according to the manufacturer's instruction. In group A all the canals were prepared using Protaper Next up to size X2 (25.06), RPM 300 and torque 200 gcm. Similarly, in group (B) One shape (25.06) was used till it reached the working length at 400RPM, in group (C) NT Gold (25.06) was used till it reaches working length at 500RPM and 2.6N torque. Each instrument was used for the preparation of up to 3 canals and then discarded, irrespective of the system to which it "belonged.[5]"

Throughout the instrumentation of each third of the root canals or after every file change, the specimen was irrigated passively with 1 mL of saline using a side vented dental needle (30 gauge). A small (1-2 mm) constant apical-coronal movement of the needle was maintained during the delivery of the "irrigant.[5,11]" In all the groups' patency was maintained by inserting a #10 k type file up to 1mm beyond apical foramen after each motion and canal irrigation "cycle.5" For each group final irrigation was 3 cycles of 2 mL 3% NaOCl (Prime) for 20 seconds each with a 30-gauge single side vented needle (Neoendo endo irrigation needles). During preparation, the tips of all activation devices, as well as the irrigation needle, were inserted as deep apically as possible without binding, but not more than 1 mm short of WL. The canal was dried with 25.06 paper points. The tooth and teflon tape were removed from the tube. The apparatus was weighed after removal of the tooth [Fig 2 (c)], and the weight of the apically extruded debris and irrigant was calculated by subtracting the pre-procedure weight from the post-procedure "weight.[6]"

Statistical Analysis:

Continuous data were summarized as Mean ± SD (standard deviation). Quantitative data was analyzed by, mean, SD, unpaired T-test. Statistical significance

P>0.05 is not significant P≤ 0.05 is significant P≤ 0.01 is highly significant
Statistics software SPSS 16.0

Results:

Table 1: Amount of apically extruded debris and irrigant according to group

Apically extruded debris and irrigant (g)				
Groups	**Min**	**Max**	**Mean**	**SD**
NT Gold	**0.015573**	**0.019147**	**0.016**	**0.0032**
One shape	**0.020057**	**0.025034**	**0.022**	**0.005**
PTN	**0.00456**	**0.007945**	**0.0067**	**0.0015**

There was a statistically significant difference between the three experimental groups. (P <.05). Among all the groups least extrusion was observed in the protaper Next group used in combination with conventional irrigation. The ranking from least to most extrusion was as follows: Protaper Next < NT Gold < Oneshape.

Discussion:

The null hypothesis was rejected considering that there was a significant difference in apical extrusion of debris and irrigant between the three Ni-Ti systems with conventional needle irrigation. In this study, the inclusion criteria were the factors that normally influenced the extrusion of debris. We compared the apically extruded debris of 3 file systems that have different designs, manufacturing methods, numbers of files. Mesial roots of mandibular molars with 10º-20º curvature were selected as it has been found in previous studies that extrusion was less in straight canals which can lead to an erroneous conclusion. It is generally accepted that differences of apically extruded debris and irrigant amongst the groups can be detected by an analytical balance. In this study, the method by Lu et al. (2013) was modified to measure the extrusion of debris and irrigant. No effort was taken to distinguish debris from irrigant because either can trigger an inter-appointment flare-up.

The presence of periapical tissue and even granulation tissue in chronic periapical periodontitis might offer resistance to apically extruded debris and irrigant in clinical conditions. A 1.5% agar gel was used to simulate periapical tissue in this study because it possesses a similar density to periapical tissues (agar: 1045 kg m_3 vs. human tissue: 1000– 1100 kg m _3). The thickness of the agar gel at the apex was approximately 1 cm as the lesions (e.g. periapical granulomas or cysts) are of different sizes and shapes. Thus, it was difficult to stipulate a definite value of the thickness of agar gel at the apex. The tubes containing the specimens were placed in opaque-coloured vials with mouths of a diameter similar to those of the tubes, thus allowing visualization only of the canal entrances during instrumentation, just as in an actual clinical situation, thus preventing the operator from influencing the results.

Arslan D et al. (2018) compared the Protaper Next file system and the OneShape file system with respect to extrusion of debris and found multiple files system extruded less “debris.13” which was similar to results of present study. However, this difference may have been found due to different cross sections. The taper of the instrument used has also been correlated to the extrusion of debris, with some studies indicating that files with greater taper could be associated with higher level of extrusion.

It is important to point out that, although the roots were instrumented with unsealed apices in this study, 1.5% agar gel method was used. This methodologic option is justified because the simulation of bone or periodontal ligament using some type of physical barrier could retain debris that would otherwise be extruded, thus compromising the reliability of the results.

Considering the limitations of the present study, it was concluded that the instruments from the Protaper Next and OneShape single file systems applied to the same Working lengths during instrumentation of moderately curved canals produced significantly different levels of extrusion of dentin debris.

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