

Evaluation of Remaining Dentin Thickness of the Distal Portion of The Mesial Root of Mandibular Molar with Protaper Gold, Neoendo and Stainless Steel (SS) Hand K Files Using Cone Beam Computed Tomography For Analysis

Abstract:

Aim: To evaluate the remaining dentin thickness of the distal portion of the mesial root of mandibular molar with stainless steel (SS) hand K files, ProTaper Gold and NeoEndo using cone beam computed tomography for analysis.

Materials and Methods: Forty-five extracted human mandibular molars were collected. Teeth were randomly assigned to three groups (n=15). Samples were stabilized on blocks of wax. The working length for each sample was determined at 1 mm short from the apical foramen by using a ISO size #15 K file. Preparation was carried out according to the manufacturer's instructions and canals were instrumented upto apically for each group. After each instrumentation, root canals were irrigated with 5.25% sodium hypochlorite solution followed by 17% EDTA solution. Final irrigation was done with normal saline. Post cleaning and shaping, cone beam computed tomography scans of all samples in the three groups were collected.

Result: Protaper Gold and NeoEndo removed more dentin than SS hand file. As the mean remaining dentin thickness for SS K file, Neoendo and Protaper was 1.30, 1.05 and 0.80mm respectively

Conclusion: Protaper Gold, NeoEndo and SS Hand files showed statistically significant difference in remaining dentin thickness of root canal length. Therefore, it was concluded that Protaper Gold file system showed a greater amount of removal of dentin as compared to NeoEndo file system & SS Hand K files.

Key-words: Remaining dentine thickness, CBCT.

Introduction:

Understanding of the internal configuration of the tooth and its anatomical variations, is essential for successful endodontic treatment, as it enables efficient cleaning and shaping of the root canal system and its proper obturation. The complex internal anatomy, often brings out difficulties that may lead to the failure of endodontic therapy from iatrogenic errors such as perforations in the mandibular molar's furcation region[1]. The zone of greatest risk during instrumentation (Berutti & Fedon 1992) and has been described as a 'danger zone' (Abou-Rass et al. 1980)[2] and has poorer prognosis than perforation that exists in the middle or apical third of the

¹ASHWINI B. PRASAD, ²ASHA JETWANI,
³DEEPAK RAISINGANI, ⁴HARSHIT SRIVASTAVA,
⁵PRACHI MITAL, ⁶AARUSHI CHOPRA

¹⁻⁶Department of Conservative Dentistry & Endodontics,
Mahatma Gandhi Dental College & Hospital, Jaipur,
Rajasthan

Address for Correspondence: Dr. Ashwini B. Prasad
Department of Conservative Dentistry & Endodontics,
Mahatma Gandhi Dental College & Hospital, Jaipur,
Rajasthan, India
Email : Juhi.dubey243@gmail.com

Received : 25 May, 2022, **Published :** 31 Dec., 2022

| Access this article online | |
|---|---|
| Website: www.ujds.in | Quick Response Code  |
| DOI: https://doi.org/10.21276/ujds.2022.8.4.5 | |

How to cite this article: Prasad, A., Jetwani, A., Raisingani, D., Srivastava, H., Mital, P., & CHOPRA, A. (2022). Evaluation of Remaining Dentin Thickness of the Distal Portion of the Mesial Root of Mandibular Molar with Protaper Gold, Neoendo and Stainless Steel (SS) Hand K Files Using Cone Beam Computed Tomography for Analysis. UNIVERSITY JOURNAL OF DENTAL SCIENCES, 8(4).

root canal[3]. This zone is present in the coronal third of the root canal or at a level below than furcation.

Another complication is the strip perforation that indicates excessive use of instruments and the thinning of the lateral root wall which could be crucial due to presence of danger zone [4].

The thickness of remaining dentin in the danger zone of root canal also affects the selection of different file systems used in endodontic practice. Thus, this study highlights the variation in thickness of dentin when diverse preparation techniques may be undertaken and their effect/correlation with stripping perforations [4].

Materials and Methods:

Forty-five freshly extracted human mandibular molars were collected and stored in normal saline solution until use. The samples were randomly divided into three groups of 15 specimens in each of them. (Group-1 SS K file, Group-2 Neoendo and Group-3 Protaper)

Test apparatus:

The working length was determined at 1 mm short from the apical foramen using an ISO size #15 K-file.

Root canal preparation:

All root canals were prepared to an ISO 20 K-file (Dentsply, Maillefer) inserted with balanced force movements through the working length, avoiding apical pressure, and under Copious irrigation.

Rotary instruments were used with Tri Auto mini (Morita Group) according to manufacturer's recommendations.

For SS hand K file (Dentsply) group, instruments of size 25/0.02 were used up to the working length of the specimen. This shaping was done in free progressive strokes without pressure. Recapitulation with smaller size files was done during chemo-mechanical preparation.

For NeoEndo group, instruments were used in a crown-down manner at 350 rpm and a torque of 1.5Ncm. The sequence of files used till the working length were size 15/0.06, 20/0.04, 25/0.06 respectively. Size 15 K-file was used for recapitulation at the working length between each subsequent file in order to prevent the apical blockage.

For Protaper (Dentsply Maillefer) group, first SX and S1 instrument was used up to the working length at 300rpm and a torque of about 3.0Ncm and subsequently files S2 and F1 was used at 300 rpm and a torque of about 3.0Ncm till working length avoiding apical pressure, and applying gentle strokes against the canal walls.

The root canals were irrigated with 5.25% sodium hypochlorite solution (Vensons, Bengaluru, India) followed by 2 ml of 17% EDTA solution (Deor Care, Kerala, India) during instrumentation. Final irrigation was done with 5 ml of saline (Claris Lifesciences, Ahmadabad, India). After each rinse, an ISO 10 K-file was inserted inside the canal to check apical patency.

Sample analysis:

Post instrumentation CBCT scans of all samples in the three groups were acquired. The images were saved and were edited with CS3 Photoshop software (Adobe Systems Inc.), recorded in Tagged Image File Format and analysed by Image Tool 3.0 software for Windows software. The narrowest area of each canal beside the concavity was measured for comparison among the three rotary systems selected for this in vitro study.

Data were analyzed using one-way ANOVA test for multiple comparisons followed by Tukey's post-hoc test for group comparisons.

Results :

Tables 1,2 shows the means and standard deviations in remaining dentin thickness for each system at greatest concavity in the distal side of mesial root of mandibular molars. The mean percentage was highest for Hand K file (1.30) followed NeoEndo (1.05) and least with Protaper gold (0.80) respectively.

Inter group comparison of RDT :

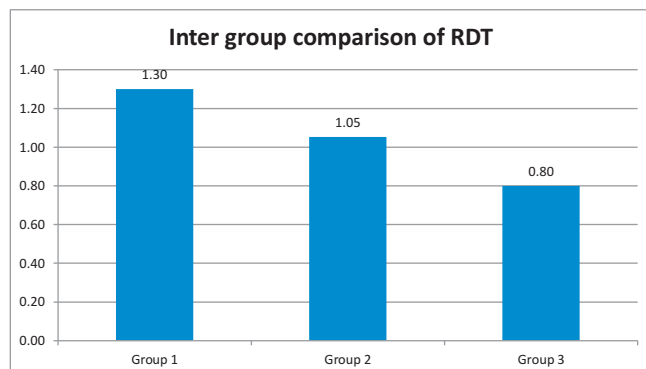
| Group | N | Mean | Std. Deviation | Std. Error | 95% Confidence Interval for Mean | | Minimum | Maximum | F value | p value of one way ANOVA |
|---------------------|----|----------|----------------|------------|----------------------------------|-------------|---------|---------|---------|--------------------------|
| | | | | | Lower Bound | Upper Bound | | | | |
| Hand K Files | 15 | 1.300000 | .1927248 | .0497613 | 1.193273 | 1.406727 | 1.0000 | 1.6000 | | |
| NeoEndo Files | 15 | 1.053333 | .1552264 | .0400793 | .967372 | 1.139295 | .8000 | 1.3000 | 29.445 | .000** |
| ProTaper Gold Files | 15 | .800000 | .1851640 | .0478091 | .697460 | .902540 | .5000 | 1.0000 | | |

There was a statistically highly significant difference seen for the values between the groups ($p < 0.01$) with higher values in group 1 & least in group 3

Inter group pair wise comparison of RDT using Tukeys Post Hoc Tests

| (I) group | (J) group | Mean Difference (I-J) | Std. Error | p value | 95% Confidence Interval | |
|----------------|----------------------|-----------------------|------------|---------|-------------------------|-------------|
| | | | | | Lower Bound | Upper Bound |
| Hand K Files | Neo Endo Files | .2466667* | .0651575 | .001** | .088367 | .404966 |
| Hand K Files | Pro Taper Gold Files | .5000000* | .0651575 | .000** | .341700 | .658300 |
| Neo Endo Files | Pro Taper Gold Files | .2533333* | .0651575 | .001** | .095034 | .411633 |

There was a statistically highly significant difference seen for the values between all the pairs of groups ($p < 0.01$) i.e. 1(Hand K Files) vs 2 (NeoEndo Files) , 1(Hand K Files) vs 3 (ProTaper Gold Files) and 2 (NeoEndo Files) vs 3(ProTaper Gold Files).



Discussion:

One of the major aims of root canal preparation, especially in narrow and curved canals, is to avoid transportation, ledge formation or perforation. Several techniques have been suggested to prevent the creation of aberrations including flaring the coronal third, which gives the operator better control of the instruments [5].

Cleaning and shaping of the root canal system with traditional hand instruments often fail to achieve optimal endodontic therapy goals. Most instruments used in endodontics are manufactured from straight metal blanks while most canals are curved[4]. Thus, inevitably it results in an uneven distribution of force in certain contact areas and the instrument seldom exhibits a tendency to straighten itself on use, within the canal. Consequently, apical canal areas tend to be over prepared toward the outer curve or the convexity of the canal, whereas more coronal areas are transported toward the concavity[5]. Such flaws in instrumentation techniques can lead to stripping perforations in the danger zone of the mandibular molar [6].

In the present study, three rotary systems namely Hand K-Files, Neo-Endo and ProTaper Gold were used to investigate the remaining dentin thickness after instrumentation in permanent first mandibular molar. Commercially numerous rotary systems are available, but tactfully choosing one system considering each canal morphology as unique in order to avoid untoward iatrogenic errors makes the clinician's decision crucial.

Tomer Ak, Gupta R et al. conducted an in vitro study to compare and evaluate the remaining dentin thickness of root canals with ProTaper Gold, NeoEndo and Revo-S systems using cone beam computed tomography for analysis. It was concluded that Protaper Gold file system removed more dentine than Revo- S and NeoEndo file system[7].

Rao MSR, Shameem A et al. did a study to compare the remaining dental thickness (RDT) in the mesiobuccal root of mandibular first molars at 3 and 7 mm from the anatomic apex after instrumentation with ProTaper, light speed LSX, K3 and M2 and to compare with that of K-files. Results showed that ProTaper removed greater amount of dentin compared to all other groups [8].

Thota S , Surakanti JR presented an in vitro study to compare canal transportation and remaining dentin thickness of hand NiTi K files, ProTaper and Wave One rotary systems using

CBCT. It was observed, ProTaper has shown significantly less dentin thickness as compared to WaveOne and Hand K files at all sections[9].

In the present study, ProTaper Gold showed more dentin removal compared to NeoEndo and Hand K files, owing to the sharp cutting edges of the convex triangular cross-sectional design and the design of its flutes that combines multiple tapers within the shaft up to 19%[9].

The Neo Endo instruments have alternating cutting edges, and this design is believed to have two functions: (i) to eliminate screwing in and blocking in continuous rotation and (ii) to reduce the working torque⁷. In the present study, NeoEndo seemed to remove the less dentin compared to ProTaper Gold, which is statistically significant and in accordance with previous studies[7].

In contrast to rotary files, Stainless steel Hand K files have shown to be effective in removing least amount of remaining dentin from the danger zone in mandibular first molars. This fact serves as a warning for the clinician and justifies the requirement for more precaution in cervical canal preparation to avert excessive removal of dentin. The pre-expansion procedures of the canal orifices may favor less invasive preparation and more emphasis on the root canal[8].

According to Schildere's, an important mechanical objective of chemo mechanical preparation is to preserve as much radicular dentin as possible so as not to weaken the root and tooth structure, thereby preventing vertical fractures[9]. Although no definitive minimum radicular thickness has been established, 0.2mm is considered critical[10].

A crucial consideration should be made over the fact that less dentine thickness increases the magnitude but not the direction of maximum tensile stress[11,12]. Versluis et al. reported that external distal and mesial surfaces of roots with oval canals showed moderate stress concentrations that were barely affected by preparations, while stress concentrations increased on roots with round canals when preparation sizes increased[13]. Therefore, better understanding of the danger zone anatomy may serve to reduce the risk of endodontic mishaps.

These results were as similar Tomer's et al, Rao's et al, Thota's et al studies [7, 8, 9].

The present study was done to simulate the clinical situation by inducing VRF. However, it is not easy to extrapolate the results directly into clinical practice as the oral conditions cannot be replicated perfectly.

The present study had a few inherent limits. First, this study is an in vitro investigation; hence the files used for cleaning could be standardized across all samples. However, in a clinical scenario, a traumatic impact will not provide such uniform fracture patterns. Further studies are required to check the effect of voxel sizes of CBCT in clinical conditions to corroborate the choice of the imaging system.

Conclusion :

Within the limitations of the present study, it has been evaluated that Stainless steel Hand K files showed the greatest amount of remaining dentin in Danger Zone of the molar while ProTaper Gold showed the least. Thus, the clinicians must be careful of the technique opted for biomechanical preparation of the tooth as well the type of instrument which best facilitates the goal of therapy. The amount of reduction in this area also determines the prognosis of the treatment planned and is critical to its long term success.

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