ISSN Print: 2394-7489
ISSN Online: 2394-7497
IJADS 2021; 7(1): 81-83

www.oraljournal.com
Received: 25-10-2020
Accepted: 05-12-2020

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Morphometric analysis of cleaning efficacy of ProTaper NEXT and Lightspeed LSX rotary system

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DOI: https://doi.org/10.22271/oral.2021.v7.i1b.1119

Abstract
Aim: The aim of the study was to evaluate the cleaning efficacy of ProTaper NEXT and Lightspeed LSX rotary system by morphometrical analysis.
Material and Methods: Ten extracted mesial roots of human mandibular molar teeth were randomly assigned in two groups ProTaper NEXT (Group I) and Lightspeed LSX (Group II). 3 serial transverse cross sections (5µm) at apical third were prepared and histologically processed. The cross sections were examined under optic microscope 100x magnification. The images were submitted to morphometrical analysis using Motic® software to determine the percentage of root canal area with debris and were analyzed statistically using Wilcoxon Rank Signed Test and one-way analysis of variance (ANOVA).
Results: Percentage debris in group I (ProTaper NEXT) was less compared to group II (Lightspeed LSX) ($p<0.0001$)
Conclusion: None of the technique was 100% effective in removing the debris, but the ProTaper NEXT system exhibited better cleaning efficacy.

Keywords: CIELAB, reflectance spectrophotometer, power bleaching, microleakage

Introduction
The main objective of biomechanical preparation is gradually increasing the instrument diameter and constant irrigation for cleaning, disinfection and shaping of the root canal in order to promote easy and adequate filling [1]. Despite the advances made in instruments and instrumentation techniques, the design and the physical limitations of the endodontic instruments can lead to inadequate cleaning of the root canal system. Shaping procedures can be completed more easily, quickly and predictably using NiTi rotary instruments, but effective cleansing of the root canal system has not yet been demonstrated [2].
It has been shown that cleaning narrow, curved and flattened root canals is not always easily accomplished, indicating that anatomic variations are also an important factor to be considered [3]. As access to the root canal system is limited and the anatomy complex, microorganisms may remain in the dentinal tubules and in other irregular spaces [4].
Debris is defined as dentine chips and residual vital or necrotic pulp tissue attached to the root canal wall, which in most cases is infected [6]. One of the most common objectives during canal instrumentation is removal of vital and or necrotic pulp tissue, infected dentin and dentin debris in order to eliminate most of the microorganisms from root canal system (European Society of Endodontology, 1994; American Association of Endodontists 1998).
Production of intracanal debris during instrumentation and the debris that can de extruded depending upon the instrumentation method, file size and file type. Both manual and mechanical instrumentation leave debris in the root canal space. These are likely to give rise to inflammation, pain, delayed healing and flare ups, which have an impact on the overall success of root canal therapy [7].
Since it has been claimed that no current technology or instrument is effective in thoroughly cleaning the root canal system, the purpose of this *in vitro* study, therefore, is to evaluate the cleaning efficacy of ProTaper NEXT and Lightspeed LSX rotary system by morphometrical analysis.

Materials and Methods

Ten freshly extracted Human Mandibular First Molars were taken in the study and required approval in accordance with the ethical standards. Radiographs were taken and the teeth were selected according to their selection criteria (Table1). Scaling was done to remove the tissue and debris and the teeth were stored in 0.1% Chloramine solution for 24 Hrs.

Table 1: Selection criteria of teeth

Inclusion criteria	Exclusion criteria
▪ Molars extracted purely because of periodontal conditions between age group of 40-60 years ▪ Root angulations of 0 - 5º and 10mm root length	▪ Root caries ▪ Internal or external resorption ▪ Root fractures ▪ Comparable root length ▪ Root canal treated

The crowns of the teeth were sectioned close to the amelo-cemental junction, with a double faced diamond disc, mounted on a high speed hand piece. Their mesial roots were separated, and initial debridement of the root canals was performed. Initial root canal exploration, was performed by using K- Type of file into the canal until it was seen in the apical foramen of each tooth and the file was withdrawn, thus determining the real working length. The working length was respected during the entire instrumentation procedure. Coronal pre-flaring was done with ProTaper SX file. The canal was prepared with #20K file and #25K file, till the working length. Standard protocol of debridement and irrigation was followed throughout the Biomechanical preparation.These mesial roots were randomly separated into 5 specimens each into two groups: ProTaper NEXT and Lightspeed LSX

The cross sections were examined with an optic microscope (×40) coupled to a computer. The images were recorded and the percentage of debris was calculated using Motic software in square micrometers. The data were statistically analyzed using nonparametric analysis of variance (ANOVA) Kruskal–Wallis test and the level of significance was set at $P<0.05$. SPSS version 22.1 software was used for statistical analysis.

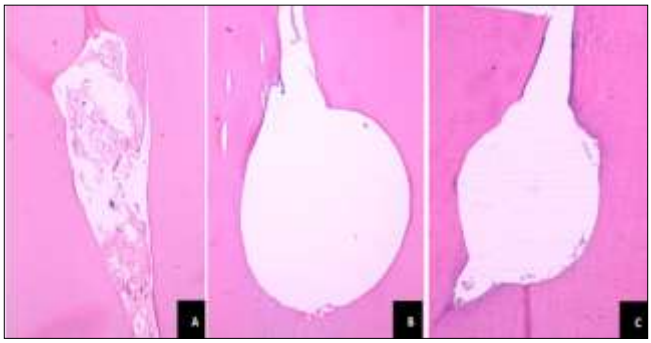

Fig 1: Histological picture of (A) Un-instrumented canal, (B) Instrumentation using ProTaper NEXT, (C) Lightspeed LSX

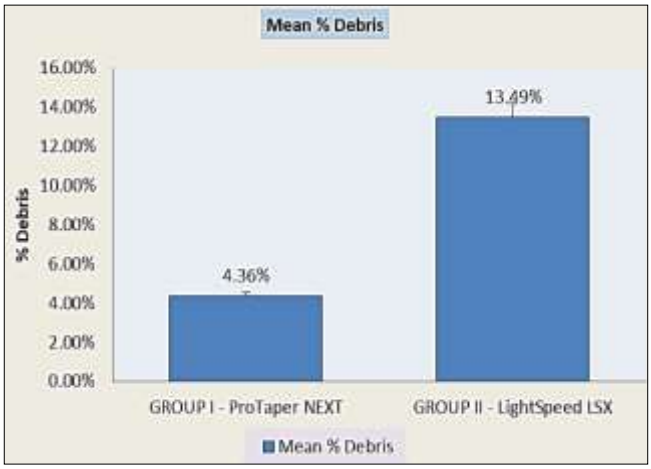

Fig 2: Percentages of debris in the two instrumentation groups

Results

Percentage debris in group I (ProTaper NEXT) was less compared to group II (Lightspeed LSX). There was statistically significant difference among the two instrumentation groups ($p<0.0001$). Neither of the instrumentation techniques showed complete removal of debris.

Table 2: Statistical analysis of % debris

Groups	Group I - ProTaper NEXT	Group II - Lightspeed LSX
Mean	4.36%	13.49%
Std Deviation	0.099	0.0788
Coeff. of Variation	22.71%	58.41%
Standard Error	0.0018	0.0144
Non Parametric Test – Wilcoxon Rank Sum Test: *p*-Value*		0.000000102410
Non Parametric Test – ANOVA Test: *p*-Value*		0.000000043873

Discussion

The success of root canal treatment fundamentally depends on cleaning, shaping, disinfecting and sealing the root canal. Cleaning occurs during the biomechanical preparation the root canal with the elimination of bacteria, their sub-products, degenerated pulp tissue and contaminated dentin, creating a relatively clean environment that facilitates proper sealing. The objective is to clean the root canal and its ramifications as thoroughly as possible, creating ideal conditions for tissue regeneration and health [8].

Various authors have demonstrated comparison of different rotary systems for debridement of the root canal space, but no technique or instrument design is totally effective in cleaning the canal. The proportion of root canal dentine surface planed by instruments has been quantified recently using high resolution computed tomography; it was found that 35–53% of the root canal surface remained uninstrumented [9-12].

Incomplete debris removal particularly in the apical region has been repeatedly demonstrated. The apical third has been evaluated in this study as it remains critical and crucial area with complex anatomy. Moreover, the apical region is associated with more irregular dentin which may contribute to higher debris [11].

The mesial roots of mandibular molars with vertussi class 4 were selected for this study. Their variation in internal anatomy of having flattened and not cylindrical canals can interfere with root canal instrumentation. Thus, tissue remnants can persist in isthmus, re-entrances and ramifications making instrumentation more difficult [3].

The most commonly used method of assessing the cleanliness of the root canal are by scanning electron microscope, section analysis and optical microscope [5]. In the present study morphometrical analysis was used with optical microscope to evaluate quantitatively and qualitatively remaining dentinal layer and debris in the root canal system by analyzing serial histological sections [13, 14]. It calculates the percentage area

occupied by the debris in relation to the total area of the root canal lumen by using Integrated grid systems [15] or softwares like Motic™ [16].

Light Speed LSX with an oval-shaped cross-section was built with a hypothesis that, it could fit more accurately in the apical region and give more reliable measurements of wider canals and accurately determine the apical root canal diameter. Peters *et al*. had suggested a better canal centring ability of Light Speed LSX than other techniques and its potential to bypass the canal curvature more readily than a more rigid stainless steel file [9].

The cleaning ability of Lightspeed LSX has been compared with K-files, ProTaper, K3 in apical and middle third. The results showed that Lightspeed LSX showed least amount of intracanal debris although it was not statistically significant. The significance of having cutting blade of 0.25 to 2 mm in length and two-point contact which performs precise cutting action and remain centred in the apical region thus reducing the intracanal debris. These advantages led to selection of Lightspeed LSX as standard for comparison, in this study.

The result of the study seems to indicate that ProTaper NEXT technique had better cleaning results in the apical third of the root canal systems than Lightspeed LSX, which may be attributed to its offset design which affords more cross-sectional space for enhanced cutting, loading, and auguring debris out of a canal compared to a file with a centred mass and axis of rotation and thereby decreasing the probability for laterally compacting debris and blocking root canal system anatomy. Also these files can cut a bigger envelope of motion compared to a similarly-sized file with a symmetrical mass and axis of rotation [17, 18]. Kocak *et al*. and Ismail *et al*. have stated that ProTaper NEXT has less debris extrusion as compared with other rotary systems.

There are very limited studies describing the comparison between ProTaper NEXT and Lightspeed LSX. The clinical advantage of ProTaper NEXT is having better cutting efficiency with same-size preparation as a larger and stiffer file with a centred mass and axis of rotation. So when ProTaper NEXT with X2 (25 #06), master apical file as compared to Lightspeed LSX (#25) was used in this study the cleaning efficacy was more and debris were less.

Both groups failed to produce completely clean canals. This is in accordance with other studies which were performed to evaluate the debriding ability of various instruments [19-22]. In addition, it was observed that some areas were uninstrumented, indicating that complete canal instrumentation was not achieved.

The results of this study confirm previous research [3], showing that the amount of debris in the root canals, after instrumentation, is related to internal anatomic characteristics. The biomechanical preparation leaves organic and inorganic debris into the root canal [6], and the results of this study are in agreement with others [23, 24], showing that neither of the instrumentation techniques used completely cleaned the root canals.

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