A Comparative Study of the Effect of Canal Preflare on Fracture Rate of Ni-Ti Rotary Files, Canal Transportation and Canal Cleanliness (An in Vitro Study)

Thesis submitted to the faculty of Oral and Dental Medicine, Cairo University, in practical fulfillment of the requirements of the master degree in dental surgery (Endodontics)

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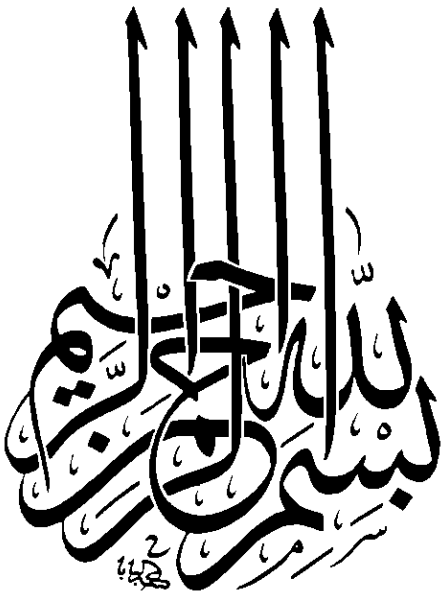
Contents



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صدق الله العظيم

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List of Tables

Introduction

Thorough biomechanical preparation of the root canal is unanimously considered to be one of the major requirements for successful endodontic treatment.

According to an old and famous endodontic axiom what is removed from the root canal is more important than what is placed inside, The phase of preparing or emptying the root canal is undoubtedly the most important, the most complex, and the most delicate among the whole procedure of root canal cleaning and shaping. Haphazard preparation of root canal that doesn't respect the endodontic anatomy will negate any attempts to obtain perfect obturation of the entire root canal system.

The goal of cleaning and shaping of the root canal system is to eliminate tissue debris, microorganisms, toxic products and reduce the number of micro organisms inside the root canal system as well as to produce a tapered shape for further obturation.

Optimum shaping and cleaning of root canals with manual files is one of the most difficult aspects of root canal treatment. It has been shown in numerous investigations that preparation of curved root canals with stainless steel instruments frequently results in undesirable aberrations such as elbows, zips and danger zones, as well as loss of working length, perforations or instrument fractures.

Recently other solutions have been suggested, a variety of techniques and instruments have been introduced for preparing root canals as the nickel titanium rotary machine instrumentation technique, it is well known for its strength and flexibility, it also allowed

manufacturers to push the boundaries of instrument design and development.

In recent years, nickel-titanium rotary systems such as, the Protaper Universal, the K3, and the Twisted Files, have significantly altered root canal instrumentation.

Thus it is our aim to study the:

1) Cleanliness.
2) Canal transportation.
3) Fracture rate of Twisted File, ProTaper and K3 rotary systems.

Aim of the Study

The purpose of this study is to evaluate the effect of canal preflare on:

1) Cleanliness.
2) Canal transportation.
3) Fracture rate of Twisted File, ProTaper and K3 rotary systems.

Review of Literature

The prime objectives of cleaning and shaping are to remove completely the organic substance that may be infected, or may become so, and to shape the root canal in conformity with the principles of obturation [1, 2].

Cleansing efficiency has been one of the issues discussed with regard to preparation techniques. It has been studied extensively, mainly by means of observation of the root canal walls and contents after preparation [3, 4].

Manual preparation techniques vary both in the type of instruments used and in the sequence of using them. The serial, or telescopic, technique was reported to be superior to other manual techniques [5].

Successful canal shaping demands that the prepared root canal provide good access for disinfectants and a good form for the fine seal of the root canal[6]. It has been shown by several investigations that shaping and filing of the root canal walls alone will not sufficiently clean the complex root canal system. Moreover, instrumentation will produce a smear layer consisting of dentin particles and pulp tissue closely adhering to the root canal wall and extending into the dentinal tubules. This smear layer may be to 2/μm thick, contain bacteria, and increase leakage of the root canal filling. Therefore, additional irrigation with antibacterial solutions or chelating agents is recommended to remove debris as well as the smear layer [7].

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aberrations such as elbows, zips and danger zones, as well as loss of working length, perforations or instrument fractures [8, 9].

The introduction of rotary nickel titanium instruments has significantly affected endodontic cleaning and shaping procedures. When NiTi instruments were first introduced to endodontics, they were recommended as an alternative to stainless steel files [10]. They stay more centered in the canal, produce rounder preparations, and reduce procedural accidents, such as transportation and ledging [11].

Procedural errors such as transportation and loss of working length were mainly associated with the use of stainless steel files that had insufficient flexibility [12].

Due to their cost, rotary NiTi instruments are commonly reused, which can result in their separation .Automated techniques utilize devices that rotate files, displace them vertically, or that do both movements.

In the past few years advanced instrument designs including non-cutting tips, radial lands and varying tapers have been developed to improve the safety of preparation, to shorten working time, and to create a greater flare of preparations. Due to these new instrument designs, advanced preparation concepts have been developed: most Ni-Ti systems with increased instrument tapers are used in a crown-down sequence.

Numerous studies have shown the ability of several new rotary nickel-titanium systems to maintain the original canal curvature and to produce a well tapered root canal form sufficient for obturation.

Root canal anatomy is intricate and thus difficult to render free from infection. The apical cross section is often oval [13, 14] and might require substantial instrumentation to remove infected dentin [15, 16] or even touch the root canal walls [17].

Mechanical instrumentation with larger apical sizes reduces infection more [18] than small apical instrumentation with increased taper [19]. Achieving a larger apical diameter is, however, difficult and might lead to more procedural errors. Although nickel-titanium (NiTi) rotary instrumentation allows for more efficiency and predictability [20] and provides better centering in canals compared with stainless steel hand instrumentation [21], curved canals might present a challenge as a result of transportation [22]. Besides the possible impact of complex anatomy [20, 22], improper straight-line access [23], file design [24, 25] and sequence [26], clinician's experience [27, 28], rotational speed [27], and inadequate use of lubricants and irrigation solutions [29], rotary file design is considered to be a major factor for a good instrumentation outcome [17]. Its influence on file transportation within the canal has been thoroughly investigated [21, 30].

File systems have characteristic cross-sectional designs and tapers. The choice of a particular system influences the ability to shape a root canal, especially in curved canals. Depending on shape, geometry, and torsional properties, the risk of procedural errors might vary. Larger files with constant taper remove disproportionate amounts of sound tooth structure in the coronal third as opposed to progressively tapered instruments. Finite element analysis showed higher flexibility of files with U-designs than convex-triangular cross sections [31]. Moreover, if the anatomy demands larger apical instrumentation, every increase in file diameter reduces the torsional flexibility of tapered instruments. Therefore, many manufacturers recommend limiting apical instrumentation to #35 in curved canals. However, to achieve tapered canal shapes for adequate obturation, it requires a step-back procedure after the final apical preparation. From the authors' experience, many

clinicians consider this very time-consuming and implement tapered systems, resulting in hybrid combinations.

Nevertheless, serious concern has been expressed about the safety of such systems, largely because of the high incidence of instrument fractures.

Endodontic instruments that fracture and remain in the canal before complete biomechanical preparation could pose a threat to the success of the endodontic treatment. NiTi rotary instruments, although more elastic than stainless steel files, can separate at any time with little or no warning. The fracturing of NiTi instruments below their elastic limits, without visible or tactile warning, can be due to the formation of slip bands in the alloy.

Manufacturers have developed and marketed many rotary systems; however, very little or no information has been provided on the number of safe uses of these instruments. Numerous investigations have addressed the length of time that these instruments can be used, yet there is a little agreement based on a clinical protocol to aid the clinician to determine how many times these instruments can safely be used [(6)].

Considerable research has been undertaken to understand the mechanisms of failure of NiTi alloy to minimize its occurrence. This has led to changes in instrument design, instrumentation protocols, and manufacturing methods. In addition, factors related to clinician experience, technique, and competence have been shown to be influential.

The objective of this study was to evaluate the cleanliness of root canal walls after the preparation using Protaper, K3, and Twisted file, as well as to determine the degree of transportation of these canals and to compare the fracture rate of the mentioned instruments.

ProTaper Universal System represents a new generation of instruments for shaping root canals, it has a unique feature: each one has changing percentage tapers over the length of its cutting blades, also have convex, triangular cross section, a changing helical angle and pitch over their cutting blades and non-cutting modified grinding tip. The Protaper system is comprised of three shaping and five finishing instruments.

Protaper rotary files are used at a constant speed between 150 rpm and 350 rpm (recommended: 250 rpm). The rotary files are used in a specific endodontic motor with torque control such as the X-Smart™ Motor.

Irrigation of the canal should be done before engaging a file, once working length is confirmed; each file is used progressively down to the working length. The shaping files (S1, S2 and SX) are used with a brushing motion while the finishing files (F1-F5) are used in 'in and out' action (not brushing).

Is a triple-fluted, asymmetric endodontic NiTi file system designed to cut quickly with unparalleled debris removal. The cross sectional design helps the instrument to resist cyclic fatigue, it has varied pitch, positive rake angle, reduced radial land with more blades, third radial land and radial land relief.

K3 is a third-generation, triple-fluted, asymmetric endodontic file system. Designed to cut quickly, efficiently and safely, with unparalleled debris removal, the K3 addresses technical and procedural issues that no other ground fluted instrument does. It is used in a speed of 300 rpm.