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## **Microleakage after root canal preparation with rotary and hand ProTaper system (in vitro study)**

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### **Abstract**

Seventy canals from 35 mesial roots of extracted human mandibular molars were selected and divided into 2 groups. The group I was prepared mechanically with ProTaper system. And group II was prepared with hand ProTaper files. All canals were obturated with Thermafil technique and Topseal sealer. Apical microleakage and the time for preparation were recorded in each sub group. Five molars were used as control teeth. All specimens were stored in 100% humidity, and were suspended in methylene blue dye for 72h. Linear dye leakage was statistically different (T-test), while time preparation between two groups was not statistically different.

**Key words: ProTaper system, apical microleakage, root canal preparation.**

### **Introduction**

Canal shaping is a critical aspect of endodontics treatment because it influences the outcome of the subsequent phases of canal irrigation and filling and the success of the treatment itself <sup>(1)</sup>. Once the canal is prepared, it should have a uniformly tapered funnel shape, increasing in diameter from the end point to the orifice: this shape provides enough space for irrigant that are important to complete the canal cleaning and allows the placement of an effective root filling <sup>(2)</sup>. Root canal preparation using traditional stainless-steel (ISO 0.02) tapered instruments by hand very often results in iatrogenic damage to curved root canals. A further disadvantage is their tendency to create narrow canal shapes which makes effective access for irrigant and obturation materials more difficult <sup>(3)</sup>.

To overcome these inconveniences, Nickel Titanium (NiTi) rotary shaping technique were developed more than a decade ago <sup>(4)</sup>. With these super-elastic NiTi instruments, achieving a correct canal shape, even in curved canals, appears to be more predictable and safe <sup>(4)</sup>. Several instrument systems manufactured from Nickel-Titanium have been introduced into endodontics practice. The specific design characteristics vary, such as tip sizing, taper, cross section, helix angle, and pitch <sup>(3)</sup>. ProTaper system is the NiTi rotary products that available know in the market <sup>(3)</sup>.

The ProTaper system is based on a unique concept and comprises just six instruments, three shaping files and three finishing files. These instruments were designed by Dr.Cliff Ruddle, Dr

John west, and Dr. Pierre Machton. ProTaper file introduce a new design with progressively increasing tapers with a multiple taper in a single instrument, triangular section, active blades and a moderately active point<sup>(3)</sup>. Several studies<sup>(5,6)</sup> demonstrate that, compared with instrumentation by stainless-steel file, NiTi mechanical preparation are more centered in canal lumen, rounder and better maintained in their original anatomy.

As a logical consequence of the success of the ProTaper rotary file, recently a ProTaper hand files are available, and because these file are also multitapered, fewer files are needed to create a tapered shape, this offers huge advantages for clinician and increases efficiency during root canal treatment<sup>(7)</sup>. So the introduction of ProTaper hand files now allow to carry out an ProTaper taper preparation but having the control of stainless steel hand file<sup>(8)</sup>. And also, as Nickel Titanium has 'excellent memory' retention the ProTaper files for hand use is better able to keep its shape<sup>(8)</sup>. To date, no studies are available on ProTaper hand file, one of the latest NiTi hand product.

The aim of this study was to compare, the preparation time, apical microleakage in curved canals prepared either by ProTaper rotary files or ProTaper hand files

## Materials and method

Thirty- five extracted human mandibular first molars were selected and stored in a 0.2% thymol solution. In addition, all mesial roots had two separated canals and separated apical foramen with similar shape and curvature. The distal roots were removed and crowns were not sectioned to simulate clinical situation. All teeth were numbered and stored for 48h in a 5% sodium hypochlorite

solution to remove attached soft tissue before access preparation. Canals were divided into two groups: for group (I), 30 canals were prepared mechanically with ProTaper system (Maillefer, Ballaigues, Switzerland). For group (II): 30 canals were prepared manually with ProTaper hand files (Maillefer, Ballaigues, Switzerland) Teen additional canals for five molars were used as control teeth. Canal length was determined visually by passing a size 10 K-file into the canal until was flush with the root surface at the apical foramen. Working length was established by subtracting 1mm from this length. Periapical radiographs were taken with file in each canal to verify the working length.

### Group 1:

All canals were prepared mechanically with the ProTaper system (Maillefer, Ballaigues, Switzerland) a system made up of six instruments. According to the manufacturer's recommendations, using a low speed hand piece (300rpm) with crown-down technique, For coronal portion of the canal start with shaping file S1 (Purple color ring) to achieve straight line access with brushing movement once resistance felt remove the file and force against the canal walls on its removal, this action performed just to remove any cervical interference. After that shaping file SX (orange ring) is used with the same manner. When the canal is patent and working length is confirmed shaping file S1 is reused to the working length with brushing motion, followed by shaping file S2 (white ring) used with the same manner till it reached the working length, followed by irrigation and recapitulation. The apical portion is prepared with finishing files, first start with F1 file (yellow ring) to working length followed by F2 file (red ring) to the working length. Finally use F3 file

(blue ring) is used to working length its tip size equal to #30 file, with that instrument the preparation of the apical portion is completed. A 5% sodium hypochlorite solution was used to irrigate the canals between usages of each instrument.

### **Group (II):**

Thirty canals were prepared manually with the ProTaper hand files (Maillefer, Ballaigues, Switzerland) a system made up of six hand instruments. According to the manufacturer's recommendations, the canals were prepared with crown down technique, For coronal portion of the canal start with shaping file S1 (Purple color head) to achieve straight line access with gently rotating the handle clockwise until the file is just snug, then the file is disengage by rotating the hand counter clockwise 45-90 degrees. The dentine cut by rotating the handle clockwise while simultaneously the file is withdrawing, repeat handle motions until desired length is achieved. After that the shaping file SX (orange head) is used with the same manner. When the canal is patent and working length is confirmed with #15, shaping file S1 is reused to the working length with the same motion, followed by shaping file S2 (white head) used with the same manner till it reached the working length. The apical portion is prepared with finishing files, first start with F1 file (yellow head) to working length followed by F2 file (red head) to the working length. Finally use F3 file (blue head) is used to working length its tip size equal to #30 file, with that instrument the preparation of the apical portion is completed.

Copious irrigation with sodium hypochlorite was used throughout the preparation procedure and the instrument regularly withdrawn to remove debris and check the flutes.

ISO files size 10 and 15 placed to length were used to maintain patency throughout preparation. The same person performed all the instrumentation.

The total time of canal preparation was recorded in minutes for the both instrumentation procedure. This included active instrumentation, irrigation and time used to exchange the instruments. After instrumentation all canals were obturated with Thermafil plus technique as specified by the manufacturer. A Thermafil obturator the same size as the size of the verifier was selected (# 30). A rubber stop was adjusted to coincide with the working distance taken from the root. The obturator was heated in the Therma Prep oven (Dentsply, Maillefer). Sterile paper points were used to coat the walls of the canal of the working length with Topseal sealer. The Thermafil obturator was inserted in the canal to the established working length. The shaft level was severed with the orifice using tungsten carbide inverted cone bur in a high-speed handpiece. The carrier was stabilized with the index finger.

After obturation of all specimens, access preparation was sealed with Coltosol (Coltene, Astralis, Switzerland) and teeth were then stored in 100% humidity for 1 week to ensure the setting of the sealer. The same person performed obturation technique. Radiographs were taken from the buccal and mesial aspect of each root to visually evaluate the obturation. For positive control, five canals were enlarged as described above, but the root canals were not filled. In the five canals serving as negative controls, the root canals were prepared and filled as described and then were completely covered with nail varnish and subjected to leakage testing.

The obturated roots were dried and coated on their external surface with nail varnish; except for the apical 2mm. after the varnish had dried the specimens were immersed in methylene blue 1% at 37°C for 72h. They were then thoroughly washed with water, the varnish was carefully removed with a Lacron, and the teeth were dried. Using a diamond disk, two grooves were made longitudinally on the roots were the splitted in half by placing the edge of Lacron carver in the grooves and applying a gentle pressure. Linear apical dye penetration was measured for each specimen using Stereomicroscope at X10 magnification. The resulting measurements of time, dye leakage were subjected to statistical analysis.

### Statistical analysis:

Independent (T) Test was used to compare group I to group II in both measurement technique.

### Results

The minimum and maximum values of mean and standard deviation values for each group are presented in table (1). T-test table (2) showed a significant difference in apical microleakage between group I and group II at P 0.05 fig. (1). Also T-test showed a non significant difference in time of preparation between rotary and hand ProTaper system table (2).

### Discussion

Besides proper cleaning and shaping of the root canal, the complete and hermetic obturation of root canal system is a major objective in root canal treatment<sup>(1)</sup>. The mean leakage and standard deviation values for each technique are presented in table (1). T-test table (3) showed a significant difference between group I and II (P< 0.05). The hand ProTaper group

showed less microleakage than rotary group.

Chris Emery says<sup>(9)</sup> " I have been using ProTaper rotaries for about two years and find them an exceptional file. However, there are always those canals that I personally feel very reticent to place a rotary full working length. These canals would usually have very acute curvature, I personally never feel quite, confident enough to use them in these cases". In a study conducted by Yun et al.<sup>(10)</sup> using plastic bokes, the ProTaper created some what more aberration than other rotary NiTi, and have less ability to stay center in the apical portion of the canal<sup>(10,11)</sup>. In hand ProTaper group instrumentation methods leave a good tactile feed back and having the control of a stainless steel hand files, and may aid removal of acute apical curvatures or ledges and provides access to apical canal areas for irrigants.

The other reassuring thing about ProTaper hand files it gets back to the basic Roan Balance Force Concept, where by we can advance a file around a tight curve using the clockwise/ anticlockwise balanced force technique and at the same time, fulfilling our biological crown down concept<sup>(9,12)</sup>. Many different explanations have been offered for the obvious and undisputed efficacy of the balanced force approach<sup>(13,14)</sup>, however, general agreement exists that it provides excellent canal centering ability, superior to other techniques with hand instruments<sup>(15,16)</sup>.

Throughout this study and in many cases we find it difficult to keep and control the rotary instrument inside of the canal within the working length more than 3 second without passing the file beyond the working length during brushing the canal on the outstroke with the ProTaper, and this may be give another reason for apical microleakage.

Assessment of linear dye penetration is a common method to explore apical microleakage of root filings after splitting the roots or after cleaning them<sup>(17)</sup>. The microleakage technique that was used in this study was a passive dye penetration. There appears to be no significant differences between the amounts of leakage obtained by passive or by negative-pressure penetration methods. Even if entrapped air exists in the root canal filing, it does not inevitably exert an influence of the dye penetration<sup>(18)</sup>.

The quest for more efficient methods of canal instrumentation is an important feature of modern endodontics. The introduction of both rotary and hand NiTi instrumentation has alleviated hand fatigue and reduces the time of preparation<sup>(3)</sup>. Many studies<sup>(19,20)</sup> found that the time used to prepare the canal with ProTaper rotary instrument required less time and effort to prepare the canal, than either hand instrument with K-file or other NiTi rotary instruments.

In this study a T-test was done for measuring the time used for the preparation procedure between rotary and hand ProTaper groups. A non significant difference was found between group I and II, with short preparation time for both (328.86), (348.7) respectively.

These results seem very logical since both rotary and hand ProTaper files follow the same protocol which involve fewer instruments change that speeding up the endodontics procedure<sup>(7,12,21)</sup>, and both of them have the same features of files. Although the cutting ability of rotary instruments is faster than hand instruments<sup>(21)</sup>, there is more time consuming was observed in the exchange the rotary file. In this study total preparation time included the time used to exchange the instruments.

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Table (1): Descriptive statistics for experimental groups

Measurement techniques		No. of canals	minimum	maximum	Mean	S.D
Apical leakage (mm)	Group I	30	0.94	2.70	1.97	1.21
	Group II	30	0.80	1.21	0.974	0.135
Preparation time (sec)	Group I	30	315.6	360	328.86	13.43
	Group II	30	324	369.6	348.7	18.34

Table (2): Student's t-test

Measurement techniques	Comparison groups	T	C.S.
Apical leakage (mm)	I vs. II	4.45	*
Preparation time (sec)	I vs. II	1.285	N.S

\* Significant

Fig.(1):Bar chart showing the differences in mean of microleakage

