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Evaluation of Two Rotary Nickel-Titanium Systems for Gutta Percha Removal during Endodontic Retreatment

Nawal A Al-Sabawi
BDS, MSc (Lec.)

Department of Conservative Dentistry
College of Dentistry, University of Mosul

الخلاصة

الاهداف: لتقييم فعالية نوعان من نظام (RaCe و ProTaper) الدوار مقارنة مع المبارد اليدوية وذلك لازالة gutta percha خلال إعادة المعالجة. كما تم تقييم وقت إعادة المعالجة ، وكمية الحطام المقذوف من قمة الجذر ، والأخطاءالإجرائية. **المواد وطرق العمل:** اربعون سن من الضواحك السفلية تم توسيعها لحجم ٣٠ ثم تم حشوه باستخدام التكثيف الطرفي لل gutta percha. ثم قسمت الاسنان عشوائيا إلى اربع مجموعات، ١٠اسنان لكل منهما. وكان أداء الإزالة بالكلوروفورم وواحدة من التقنيات التالية: (الأول) Hedstrom و K-file ، (الثاني) Hedstrom و ال (ProTaper) اليدوي، (الثالث) ProTaper الدوار ، و (رابعا) RaCe. الوقت الذي تم فيه إعادة المعالجة، وقيمة الحطام المقذوفة من قمة الجذر، والادوات التي كسرت قد تم تسجيلها. الجذر قسم طوليا وتم التقاط صورة له تحت المجهر المجسم ب(X 10) ، ثم تم قياس مساحة ما تبقى من مواد الحشو والمساحة كلها من القناة باستخدام برنامج SigmaScan. وقد تم تحليل البيانات إحصائيا باستخدام طريقة التباين الاحادي واختبارتوكي. **النتائج:** ترك النظامين الدوارين اقل مواد حشو متبقية وكان سريعا ونتج عنه كمية حطام مقذوف من قمة الجذر قليلة بحيث كانت معنويا مختلفة عن المبارد اليدوية. لم يكن هناك فرق معنوي بين النظامين الدوارين، ولكن كان هناك فرق معنوي بين المبارد اليدوية بشأن الكمية المتبقية من مواد الحشو. فقط RaCe لم يحصل له كسر خلال إعادة المعالجة. **الاستنتاجات:** تم العثور على انه النظامي الدوارين لهما فعالية كبيرة وسرعة فائقة في إزالة gutta percha خلال عملية إعادة المعالجة اللبية.

ABSTRACT

Aims: The purposes of this study were to evaluate the efficacy of two rotary systems (RaCe and ProTaper) compared with hand files, in the removal of gutta percha during retreatment. Retreatment time, amount of apically extruded debris, and procedural errors were also evaluated. **Materials and Methods:** Forty extracted mandibular premolars were instrumented to size 30 and obturated with lateral condensed gutta percha. Then teeth were randomly divided into four groups, 10 teeth each. Removal was performing with chloroform and one of the following techniques: (I) Hedstrom and K-files, (II) Hedstrom and hand ProTaper, (III) Rotary ProTaper, and (IV) RaCe. Retreatment times, apically extruded debris, and broken instrument were recorded. The root split longitudinally viewed under stereomicroscope at (10 X) photograph are taken, and then the area of remaining filling material and whole area of the canal were measured using SigmaScan software. Data were analyzed statistically using one way ANOVA and Tukey test. **Results:** The two rotary systems left significantly less remaining filling material, faster, and produce less amount of apically extruded debris compared to hand files. There was no significant difference between the two rotary systems, but there was significant difference between the two hand files regarding the amount of remaining filling materials. Only RaCe exhibits no fracture instruments during retreatment. **Conclusions:** The two rotary systems were found to be effective and faster in removing gutta percha during endodontic retreatment.

Key words: RaCe, ProTaper, endodontic retreatment, gutta percha removal, rotary systems.

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INTRODUCTION

The primary goal of the endodontic therapy is to completely fill and seal the root canal system. If these parameters are not achieved during endodontic therapy, failure might result. An interventation is needed to correct the failure of the initial root canal treatment, disinfecting, and achieving better design. Endodontic retreatment is considered as the first choice, leaving surgery to correct a possible retreatment failure caused by remaining microorganism in the periradicular tissues.[1]

Endodontic retreatment requires regaining to the apical foramina by complete removal of root canal filling material thus facilitating sufficient cleaning and shaping of root canal system and final obturation. The risk of misshaping the canal by producing perforation while removing the obturation material is related to the

instrument and the motion used.[2]

Gutta percha, in combination with sealer cement, can be removed by several methods such as: solvents, K-type or Hedstrom files, Gate Gildden drill, heat pluggers, ultrasonic technique, and laser. Additionally rotary instruments can also be used, such as inflexible XGP drill, the canal finder, or more recently flexible rotary nickel– titanium (NiTi) files in a slow speed hand piece. All pervious methods may be individually applied or combined for removal of filling material.[3,4]

During endodontic retreatment a solvent can facilitate the removal of gutta percha by softening it. Chloroform has been considered the most popular gutta percha solvent because of its ability to dissolve gutta percha very rapidly.[4]

Currently, nickel titanium rotary instruments like Reamer with alternative Cutting edges (RaCe), ProTaper, and Greater Taper (GT) rotary have an important role in the removal of filling material for their ability to simulate canal curve and effectively produce well tapered root canal form requiring less time.[5]

Purposes of this study are to evaluate the efficiency of hand files (Hedstrom and K-flex files, Hedstrom and ProTaper hand files) versus ProTaper and RaCe NiTi rotary instruments in the removal of filling material from root canal. The time taken for removal, procedural errors (broken instrument that occur during retreatment), and the amount of apically extruded debris in each group used during retreartment were also evaluated.

MATERIALS AND METHODS

Prepared Samples:

Forty freshly extracted human mandibular premolars with a single straight canal and completely formed apex were selected and stored in 10% formalin. Then teeth were decoronated at 16 mm from the apex using diamond disc bur (KG Sorensen SP, Brazil) and a size 10 K-file (Mani, Inc. Japan) was passed 1 mm beyond the apex of each canal to confirm patency. The same file was introduced into the canal until being visible at the apical foremen and the working length was recorded as being 1 mm less than that length. All canals were prepared using modified step back flare technique, whereby flaring the cervical third with Gate-Glidden drill (Dentsply Maillefer, Switzerland) sizes 1-3. Cleaning and shaping was carried by sequential use of K-file up to size 30, followed by step back procedure in 1 mm increment to a file size 50. Frequent irrigation with 2.5% sodium hypochorite was used between each file changes. A working length 15 mm was established in all teeth. Root canal were obturated with gutta percha (Dia Dent, Korea) and Tgadseal sealer (Technical & General LTD. London-United Kindom) using cold lateral compaction method, a master cone size 30 was selected and tug back was checked then accessory cones size 25 were laterally compacted. The access cavity was closed with composite restoration (Seramco, Switzerland). All teeth were stored in distilled water at 37^0C for 4 week to simulate as possible the clinical procedure. Standard obturation was obtained with use of buccolingual and proximal radiographs to examine quality, apical extent and gutta percha condensation.[5,6,7,8,9]

Retreatment Techniques:

The teeth were secured for retreatment and debris collection according to the technique describe by Kumar *et al* [5], and Huang *et al* [9] The teeth were mounted into plastic tubes with acrylic resin with coronal part extend 2 mm beyond the upper opening of the tube and 5 mm of the apices embedded in wax. The wax was removed so that the apices became visible and pre-weighed plastic caps were attached below to collect the extruded material as shown in Figure (1).

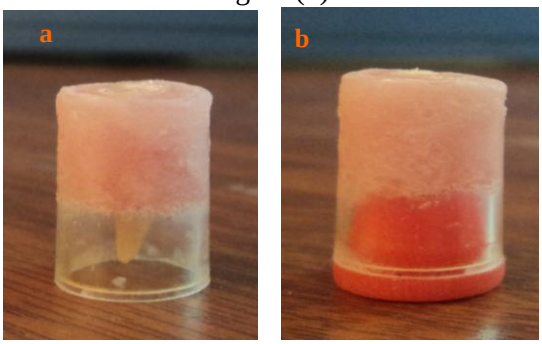

Figure (1): Prepared Sample. (a) Showing five millimeters of apical root was exposing. (b) Placement of cap for collection of apical extruded debris.

The samples were randomly divided into 4 groups with 10 specimens in each group. Access was gained, and all the roots had 4 mm of obturation removed from the cervical part of the canal using Gate-Glidden drill sizes 1-3. After that gutta perch was removed using 0.1 ml chloroform (Merck, Germany) and one of the following instruments:

Group I: Hedstrom (Mani, Inc. Japan) and K-flex files: following placement of chloroform (0.1 ml) in the coronal canal, Hedstrom ISO sizes #30, #25, #20 was used for deep penetration in crown down technique until reach the working length. The removal of filling materials were completed with K-flex files with apical enlargement till #30 and step back till #50 in a quarter-turn filing motion.

Group II: Hedstrom and ProTaper hand files (Dentsply Maillefer, Switzerland): initial pentration was done with Hedstrom in same manner as describe on group I. Then, gutta percha removal was accomplished with ProTaper hand finishing files F1, F2, and F3 in a brushing motion.

Group III: ProTaper NiTi rotary instruments (Dentsply Maillefer, Switzerland): ProTaper files were set into contra-angle rotary hand piece (Endo-Mate DT, NSK NAKANISHI, INC., Japan) with permanent rotation speed (300 r.p.m.) and torque 3 Nm. As suggested by manufacturer, following placement of chloroform, gutta percha was removed by the following sequence using light apical pressure: F3 (#30, taper 0.09), F2 (#25, taper 0.08), and F1 (#20, taper 0.07) were used in a crown down technique until working length had been reached. F2 and F3 were again used to the working length to complete gutta percha removal and cleaning of the canal wall.

Group IV: RaCe NiTi rotary instruments (FKG, Switzerland). RaCe instruments were set in same manner as mentioned before on group III. Gutta percha was removed by the following sequence using light apical pressure: files (#35, taper 0.08), (#25, taper 0.06), and
(#25, taper 0.04) were used in a crown down technique until working length had been reached. Then, files #25 and #35 were again used to complete gutta percha removal and cleaning of the canal wall.

A total of 0.1 ml chloroform was used for each tooth which left for 30 second before starting the retreatment. Files were wiped regularly using gauze to remove obturation material and debris. Preparation was deemed complete when there was no gutta percha/sealer covering the instrument. Each canal irrigated with 2ml of 1% sodium hypochlorite and dried with paper point. One set of instrument was used for five canals. There was no reinstrumentation, since the aim was only to determine the efficacy of desobturation.

Evaluation of Retreatment:

Canal Wall Cleanliness and Apical Extruded Debris:

A plastic caps were taken out and reweighed using digital scale (Mettler type, Germany) to calculate amount of apical debris. This calculation was achieved by subtracting the weight of caps from combined weight of cap and debris. Then, the acrylic resin was removed using diamond disc and forceps, the root were sectioned longitudinally in a buccolingual direction into two halves with diamond disc and vertically with a chisel. Each halves of the root was photograph by computer connected to stereomicroscope (10 X) (Motic, Taiwan). In each halves the area of remaining filling material and the area of canal were measured in mm using SigmaScan software (Jandel Scientific, USA) (Figure (2)). No attempts were made to distinguish between residual gutta percha and sealer. The ratio of gutta percha and sealer to the whole area of canal is then calculated.[8,10,11]

Time for Retreatment:

The time elapsed from entering the canal with Gate-Glidden bur until completion of retreament was recorded to the nearest second with a stop watch.[6,10,11,12]

Procedural Errors:

The number and sort of fractured instrument were recorded**.**

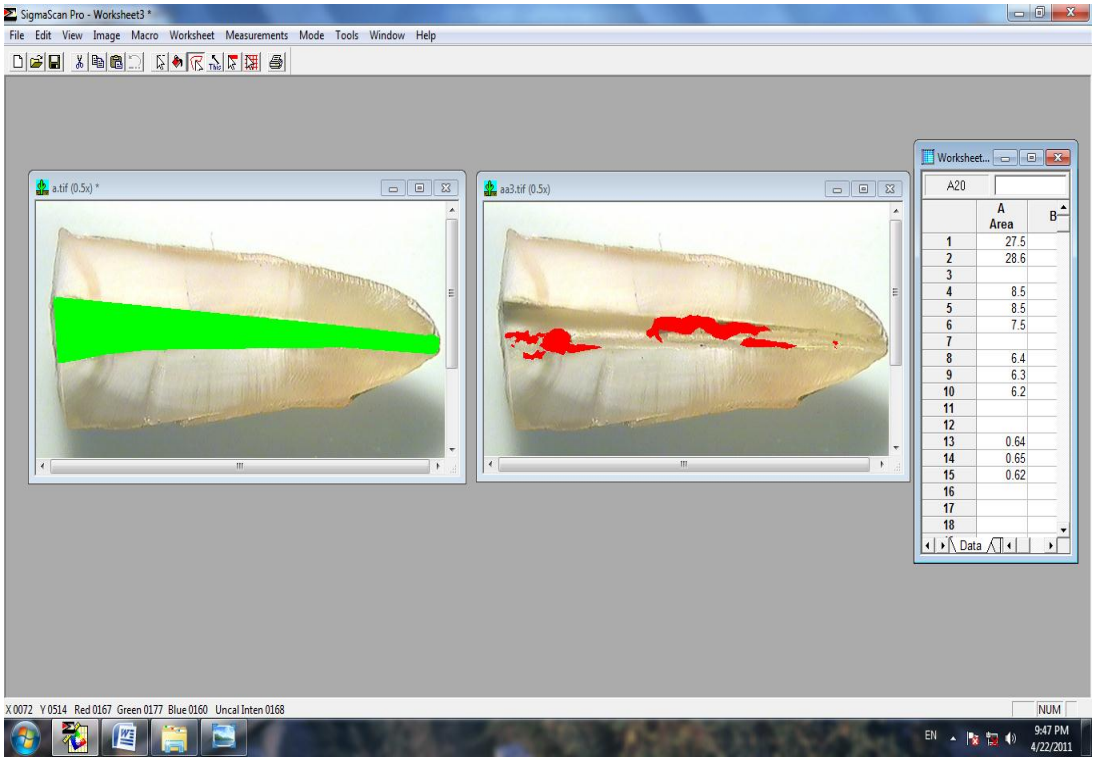

Figure (2): Sample showing the measurement of the area of canal and remaining filling materials using SigmaScan software.

RESULTS

Statistical analysis was performed for multiple groups comparisons by using one way analysis of variance test, followed by Tukey post Hoc multiple range test at level of significance $P<0.05$. This was shown in Tables (1) and (2).

RaCe and ProTaper rotary files performed significantly better result than hand files in removing the filling from the canal. However, RaCe produces least ratio of remaining filling but significantly not different from ProTaper. Also, ProTaper hand file will be significantly more efficient than K-file in removing filling from the root canal. As shown in Figure (3).

RaCe and ProTaper retreated group took least time which were significantly different from the two hand files retreated groups, but significantly no different between them. However, ProTaper hand files required least time than K-file but significantly not different.

The two rotary files produce least weight of apical extruded debris which was significantly different from the two hand files. On the other hand, there was no significant different between the two rotary files. Also, the two hand files significantly not different.

Two Hedstrom (#20, #25), one K-file (#25), one ProTaper hand files (#F1), and one ProTaper rotary files (#F1) were broken during retreatment.

Table (1): One way analysis of variance for the differences on the remaining filling materials, times required, weight of apically extruded debris among different retreatment techniques.

		Sum of Squares	df	Mean Squares	F	*P*-value*
R.F.M[1]	Between Groups	143.83	3	47.94	329.69	0.000
	Within Groups	5.23	36	0.14		
	Total	149.06	39			
A.E.D[2]	Between Groups	0.015	3	0.005	180.069	
	Within Groups	0.001	36	0.000		0.000
	Total	0.016	39			
R.T[3]	Between Groups	240.97	3	80.32	97.64	0.000
	Within Groups	29.61	36	0.82		
	Total	270.59	39			

[1]=remaining filling material. [2]=apical extruded debris. [3]=retreatment time.
*$P \leq 0.05$ mean significant different exist.

Table (2): Tukey test for the differences of the remaining filling materials, times required, weight of apically extruded debris, and number of fractured instruments among different retreatment techniques.

Techniques	Mean±SD			No. of Fractures
	Ratio of R.F.M[1] (mm^2)	A. E. D[2] (gm)	Retreatment Time (min:sec)	
Hedstrom and K-Files	8.29±0.30 **C**	0.072±0.004 **B**	11: 46±0.54 **B**	1 (Hedstrom #20) 1 (K-file # 25)
Hedstrom and Hand ProTaper	6.34±0.32 **B**	0.064±0.005 **B**	10:14±0.45 **B**	1 (Hedstrom #25) 1 (ProTaper #F1)
Rotary ProTaper	4.00±0.53 **A**	0.031±0.004 **A**	6:38 ±0.63 **A**	1 (ProTaper #F1)
RaCe	3.60±0.32 **A**	0.027±0.005 **A**	5:18±0.62 **A**	No fractured instruments

The different letters vertically mean significant difference exist
[1]=remaining filling material. [2]=apical extruded debris.

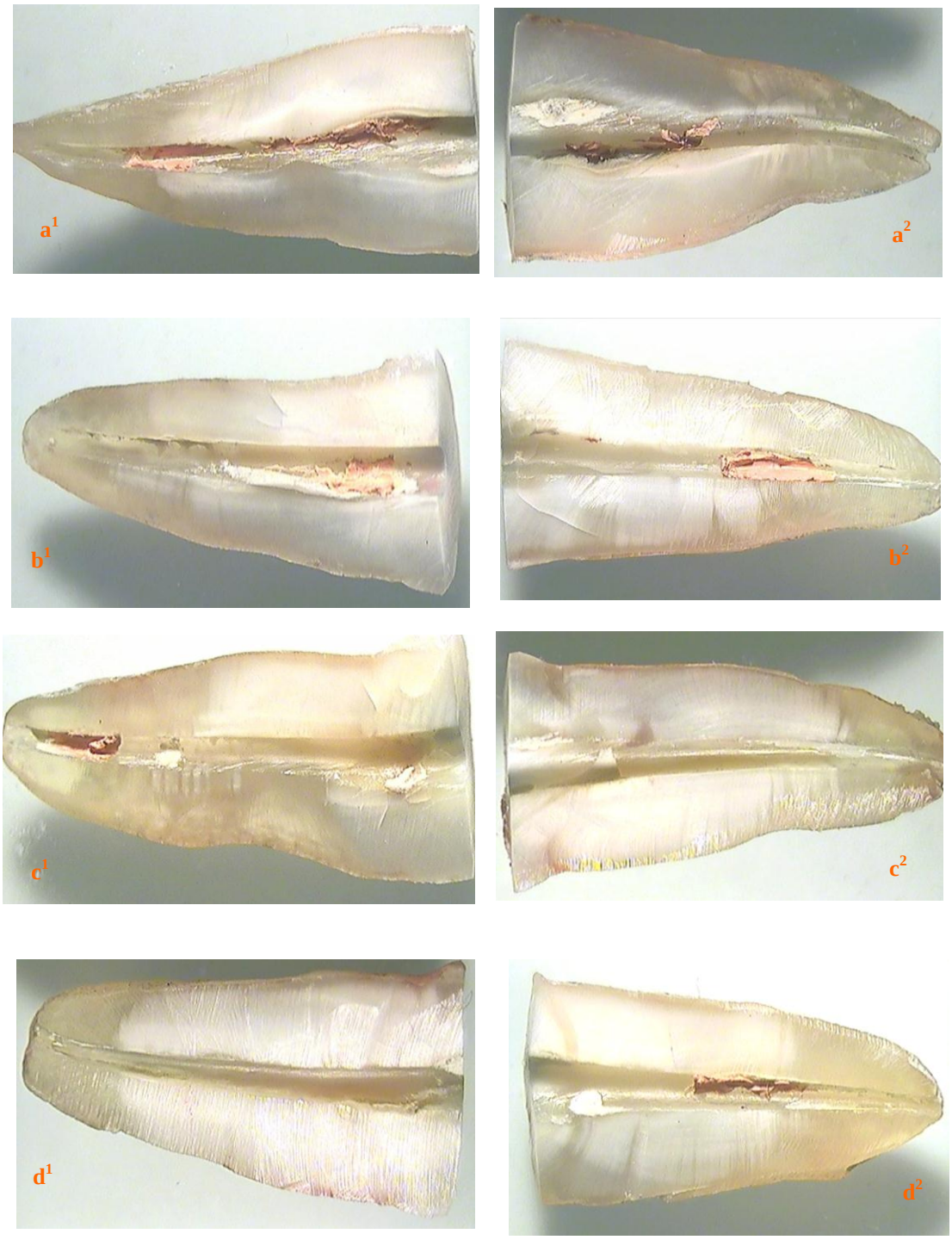

Figure (3): Samples showing the remaining filling materials left after different retreatment techniques.
(a^1, a^2)=K-Files. (b^1, b^2)=Hand ProTaper. (c^1, c^2)=Rotary ProTaper. (d^1, d^2)=RaCe.

DISCUSSION

Endodontic retreatment has largely replaced periradicular surgery for management of failed root canal treatment. A prerequisite for successful root canal retreatment is to remove as much sealer and gutta percha as possible, thereby facilitating sufficient cleaning and shaping of the root canal and final obturation.[1,7]

It has been reported that rotary NiTi instruments to be superior in their physical properties compared to hand instru-

ment. In addition, they have been suggested for initial enlargement of root canals with no danger of procedural hazards such as straightening, zipping and loss of working length.[2,3,6]

In this study, chloroform will be used in combination with the instrument because of gutta percha in the root canal exerts resistance to the instrument and risk of instrument breakage and altering of canal morphology is increased. Therefore, gutta percha should be softened in order to reduce or completely eliminate its resistance.[4]

The findings of the present investigation showed that the two rotary NiTi instruments types (RaCe and ProTaper) and ProTaper hand files were significantly more effective in removing gutta percha from whole root canals compared to the hand instruments (K-file). It was observed during retreatment that RaCe and ProTaper (rotary and hand), progressive increasing tapers, the convex triangular cross section design of the cutting blade, and modified guiding tip are deigned to increase the cutting efficiency so that these instruments would frequently removed large amounts of gutta percha in spirals around the instrument, while K-file only removed small increment of gutta percha that can not adhere to the instrument.[1,5]

Also, it has been found that the two rotary instruments were more efficient than ProTaper hand instruments in removing gutta percha. This may be due to that rotary instruments could further softening the gutta percha by frictional heat result from rotation and thus gutta percha engaged by the instrument flutes and removed more effectively.[1,5,11]

RaCe instruments produce better removal efficiency of gutta percha from ProTaper rotary instrument. Probably this result from a fact that RaCe instruments (#35) was made from stainless steel which had a better cutting efficiency than NiTi file, other advantage of RaCe could be the alternating cutting edges which not allow undesirable screwing effect and can be clean easily as gutta percha would not adhere tightly on it, and also RaCe group final apical preparation diameter was of #35 compared to ProTaper group which was of #30. Therefore, RaCe would efficiently remove debris from root canals and showed least remaining of obturating materials.[5]

In the present study, the time recorded for retreatment was significantly less using the two types of rotary instrument when compared to the hand instruments. This could be due to the rotational speed at which the rotary instrument were used plasticized the gutta percha. The plasticized gutta percha would have less resistance to removal, so that rotary instrument would remove gutta percha quikly. So; this may result in reduction of the time required. RaCe took less time than ProTaper , this possibly might result from design of RaCe in which gutta percha less adhere to the flute and can be easily cleaned therefore, the files had better cutting efficiency. Increase cutting efficiency decreases the time required for retreatment.[5,11]

The finding of present study revealed that apically extruded debris by two rotary instruments was significantly less than the two hand instruments. This may attribute to the fact that the rotary instrument tend to direct the debris toward the coronal orifice rather than the apical exit. The apically directed pressure used to facilitate file penetration on rotary files would be less than hand files, thus hand files may result in apical flare up more than rotary files and this lead to more amount of apically extruded debris by hand files. Several study demonstrated that the apically extruded debris might result in postinstrumentation flare-up clinically or even failure of apical healing.[5,6,12]

During retreatment in this study, it was found that the risk of instrument fractures of ProTaper rotary files and hand instruments seems to be higher than that of RaCe system, the reason could be related that since RaCe files utilize reduce working torque there was no fracture of any its instrument might occur in comparisons with other instruments used.

Results of the present study were in accordance with previous studies reported by Bharathi and Chacko [12], Kosti *et al* [8], Gergi *et al* [7], Tasdemir *et al*.[6], Gu *et al* [2], Kumar *et al*.[5], Sandhya *et al* [1], and Bhat *et al* [11], who reported that rotary instruments were more efficient and quick

methods for gutta percha removal than hand instruments during endodontic retreatment.

Under the present experimental conditions and limitations, the rotary systems (RaCe and ProTaper) seemed to be effective alternative retreatment techniques for gutta percha obturated root canal. Also it was found in this study that complete removal of filling material is often difficult to accomplish. So that, effective removal of filling material should be followed by a chemomechanical instrumentation technique that would correct canal irregularities after the first endodontic therapy.

CONCLUSIONS

The two rotary instruments (RaCe and ProTaper) were significantly more efficient, faster in removing filling materials, and produce least amount of apical extruded debris in comparisons with hand instruments. By comparing both rotary techniques, RaCe was more effective but significantly not different from ProTaper. ProTaper hand instruments were significantly more effective than K-files in removing filling material during retreatment. The risk of instrument fractures of ProTaper and hand files seems to be higher than RaCe.

REFERENCES

1. Sanhya UM, Nainan MT, Mangala TM, Shrad K. To treat and to retreat "ProTaper universal rotary system, the double delight". *Endodont*. 2009; 2: 42-46.
2. Gu LS, Ling JQ, Wei X, Huang XY. Efficacy of ProTaper universal rotary retreatment system for gutta percha removal from root canal. *Int Endod J*. 2008;41:288-295.
3. Bueno CES, Delboni MG, Araujo RA, Carrara H, Cunha RS. Effectiveness of rotary and hand files in gutta percha and sealer removal using chloroform or chlorhexidine gel. *Braz Dent J*. 2006;17:139-143.
4. Filho MT, Orlando TA, Bortoluzz EA, Silva GF, Tanomaru JMG. Solvent capacity of different substances on gutta percha and resilon. *Braz Dent J*. 2010;21:46-49.
5. Kumar D, Gokul P, Shivanna V. A comparison of the relative efficacies of hand and rotary instruments in the removal of gutta percha from the root canal during retreatment using stereomicroscope-An In- vitro study. *Endodont*. 2008;2 :5-11.
6. Tasdemir T, Er K, Yildirim T, Celik D. Efficacy of three rotary NiTi instruments in removing gutta percha from root canal. *Int Endod J*. 2007;41:191-197.
7. Gergi R, sabbagh C. Effectiveness of two nickel titanium rotary instruments and a hand file for removing gutta percha in severely curved root canals during retreatment: an ex vivo study. *Int Endod* J. 2007; 40:532-537.
8. Kosti E, Lambrianidis T, Economides N, Neofitou C. Ex vivo study of the efficacy of H-files and Ni-Ti instruments to remove gutta percha and four types of sealer. *Int Endod J*. 2006;39:48-54.
9. Huang X, Junqiling, Gu L. Quantitative evaluation debris extruded apically by using ProTaper universal rotary system in endodontic retreatment. *J Endod*. 2007;33:9-13..
10. Zarei M, Shahrami F, Vatanpour M. Comparisons between gutta percha and resilon retreatment. *J Oral Sci*. 2009;51:181-185.
11. Bhat SV, Suvarna N, Shetty HK, Varma R. Comparison of efficiency of gutta percha removal in retreatment using ProTaper retreatment files, RaCe instruments with and without 'H' files-An ex-vivo evaluation. Endodont. 2010; 2:33-43.
12. Bharathi G and Chacko Y. an in vitro analysis of gutta percha removal using three different techniques. *Endodont*.2002;14:41-45.