A Comparison of the Effectiveness of Reciprocating System with Continuous Rotary Systems in Non-Surgical Endodontic Retreatment (An *In vitro* study)

Ayad M. Mahmoud Al-Obaidi, B.D.S., M.Sc. [(1)]
Yasameen Hasan Motea, B.D.S., M.Sc. [(1)]

ABSTARCT

Background: Optimal root canal retreatment was required safe and efficient removal of filling material from root canal. The aim of this in vitro study was to compare the efficacy of reciprocating and continuous motion of four retreatment systems in removal of root canal filling material.

Materials and Methods: Forty distal roots of the mandibular first molars teeth were used in this study, these roots were embedded in cold clear acrylic,roots were instrumented using crown down technique and rotary ProTaper systemize Sx to size F2 ,instrumentation were done with copiousirrigation of 2.5% sodium hypochlorite and 17% buffered solution of EDTA was used as final irrigant followed by distilledwater, roots were obturated with AH26 sealer and Protaper gutta-percha point F2 and medium fine accessory gutta-percha using lateral condensation technique,roots were left for 7 days with 100% humidity at 37ºC in an incubator. Roots were randomly divided into four groups according to technique used for removing the root filling material (ten teeth for each group): group I: reciprocating technique and Wave One system, group II: continuous technique and ProTaper retreatment system, group III: continuous technique and R-Endo system, group IV: continuous technique and D–RaCere treatment system. All the roots were radiographed before and after removal of gutta-percha from both bucco-lingual and mesiodistal directions using custom made platform and digital radiograph system RVG to havea digitized images. The total surface area of all root canals was measured before removal ofthe gutta-percha and the area of the remaining gutta-percha filling in the canals after retreatment procedure from both directions. These measurements were analyzed with Adobe Photoshop CS6 software, the percentage of removed gutta-percha calculated.

Results: Statistical analysis was performed and the result showed group Ihad the highest mean values in removal of root canal filling material in both bucco-lingual and mesiodistal direction of dental radiograph and there were significant difference between group I and most of the other groups ,there were non significant difference between group II,group III and group IV.

Conclusion: This study was showed all the used retreatment systems did notcompletely remove the root canal filling material. The reciprocating technique was most effective method for removing gutta-percha and sealer than continuous rotary technique.

Key words: Retreatment, reciprocating motion, root canal filling, rotary instrument. (J Bagh Coll Dentistry 2016; 28(1):57-62).

INTRODUCTION

Safe and efficient removal of the root canal filling material was essential for optimal root canal retreatment. Ideally, all sealer androot canal material should be removed from canal walls to regain access to microorganisms and pulptissue remnants thatmightberesponsible for periapical inflammation and thus post treatment disease [(1,2)].

Gutta-percha was the most commonly used root filling material in conjunction with a sealer. The proper removal of these materials from inadequately prepared and filled canals required a substantial effort and could be time-consuming and challenging. Nevertheless, performing this procedure effectively had an important clinical impact because the irrigating solutions and the instruments used during retreatment could reach the entire root canal system, thus promoting better cleaning and disinfection [(3)].

Various techniques were used for removal of gutta-percha such as hand instruments with or without chemical solvents, rotary instruments, heat and ultrasonic devices [(4,5)].

(1)Assistant Lecturer. Department of Conservative Dentistry, College of Dentistry, University of Baghdad.

The nickel-titanium (NiTi) rotary instruments used for root filling removal and rootcanal retreatment had been widely investigated [(6)]. Their use allowed gutta-percha removal with no solvent[(7)], thus prevented the formation of a thin film of gutta-percha on the walls of the root canal[(8)].

A new concept was recently introduced, in whichcanal preparation was accomplished using a specificallydesigned nickel–titanium engine-driven instrumentthat employed a reciprocating motion. The same techniquewas also indicated for retreatment purposes, inwhich the instruments were used with a brushingmotion against the lateral walls of the canal toremove any residual filling material [(9,10)].

There were only a few reports analyzed the performance of reciprocating instruments in endodontic retreatment [(11)].

Different methodologies had been used for the evaluation of the cleaning efficacy of different endodontic retreatment systems including longitudinal cleavage of teeth [(12)]; association of longitudinal and transverse cleavage for evaluation in thirds and cleavage and

photographic recordingor with the operating dental microscope [13,14]. Others methods used radiographic examination with different computer software [15].

In the present study, radiographic evaluation of the retreatment techniques were used, this method is more reliable as splitting the roots might disturb the remaining filling material [16], bucco-lingual and mesiodistal images were taken and evaluated for each root to overcome the limitation of the radiographic images of providing only two dimensional information,. In accordance with other studies [17]. The aim of this studywould be to evaluate the effectiveness of reciprocating system versus continuous rotary systems in endodontic retreatment.

MATERIALS AND METHODS

Forty extracted human distal roots of mandibular First molar with mature apices were selected for this study from the clinics of the University of Baghdad, College of Dentistry. The gender, pulpal status and reason for extractionwere not considered and criteria for teeth selection included the following: mature, centrally located apical foramen, Patent apical foramen, roots devoid of any, cracks, resorptions or fractures.

Samples Preparation:

The extracted teeth stored indistilledwater at room temperature any remnants of soft tissue and calculus on the external root surface were mechanically removedwithsharp periodontal curette. A magnifying eye lens and light cure device were used toverify the root surfacesfor any visible cracks orfractures.The teeth were decoronated at the cemento-enamel junction using a high speed diamond burwith straight handpiece and water spray and the distal roots separated from the mesial roots.

Clear cold cure acrylic was mixed andplaced in a rubber mold where the rootswere embedded. A bench vice was used to achieve standardized position of the resin mounted roots throughout the whole procedure.

Barbed broach was used toremovethe pulpal tissue and the working length of each canal established with size 15 K-file 1mm short of the anatomical apex. The canals were instrumented using a crown-down technique with Protaper NiTi rotary instruments (Sx-F2) (Densply, Maillefer/ Switzerland) and e3 torque control electricmotor (Dentsply, Tulsa) which was set according to manufacture's instructions. Master apical file would be F2 for all canals. Alternative irrigation with total of 10 ml of 2.5% of sodiumhypochlorite (NaOCl) was used for irrigation and the smear layer was removed by irrigating with 5ml of 17% EDTA for 1 minute thenfollowed by a final rinse of 5 ml of distilledwater to avoid development of NaOC1 crystals. The canals were then dried with Protaper paper points F2.

Canal Filling:

AH 26 root canal sealerwas mixed according to the manufacturer's instructions .The mixture had a homogenous creamy consistency with string out at least 1 inch when the spatula was raised slowly from the glass slab. The sealer was introduced into the canal using ProTaper paper point F2 by rotating the paper point twice counter clock wise to coat the canal walls by thin film of sealer.The canals werefilled using the lateral condensationtechnique. The tip of master gutta-percha cone corresponding to the last file size F2 (Densply, Maillefer/ Switzerland) was dipped into the sealer and placed into canal. The previously checked finger spreaderwere used for lateral compaction of the master conecreating a space for an additional accessory cone.Medium-fine accessory gutta-percha cones were laterally compacted until the spreader could not introduced deeper than 2-3 mm into the root canalorifice. A heated plugger was used to cut the gutta-percha at the entrance of the canal. Each canal orifice was sealed by temporary filling. Prior to temporary filling placement the specimens were radiographed in bucco-lingual and mesiodistal directions to confirm the adequacy of the root canal obturation and these radiograph images were used later to make measurements of total canals area. All roots were left for 7 days with 100% humidity at 37ºC in an incubator.

Retreatment Techniques:

The coronal 2-mm of each root canal filling was removed using GatesGlidden burs 2 and 3 (Dentsply, Maillefer). Gutta-percha obturation material was then easily removed from the canal with rotary retreatment files systems.Each rotary system wasused withe3torque control electric motor (Dentsply, Tulsa).The torque and speed settings for each filewere used as recommended by the manufacturer. A total volume of 25 mL of2.5% NaOCl was delivered from aneedle with30-gauge (tip size 25) during retreatment procedure then the canals were dried with paper points.

The roots were randomly divided into four groups of ten roots each.

Group I:

Gutta-percha obturation material was removed from the canal with the primary wave one file #25 thatwasapplied in a reciprocating motion. The

silicone stopper was set on the primary wave one file (Dentsply, Maillefer) at 2/3 of the estimated canal length. Primary wave one file was introduced into the canal with a slow in-and-out pecking motion without pulling the instrument completely out of the canal. The amplitude of the in- and out- movement did notexceed 3-4 mm. Gentle apical pressure wascombined with a brushing action against the lateralwalls. The instrument advanced easily in the obturation material and the canal in an apical direction. After maximum three in- and out-movements, or when more pressure was needed to make the instrument advance further in the canal, or when resistance was encountered, the instrument was pulled out of the canal to clean the flutes.The canal was copiously irrigated with sodium hypochlorite. Primary wave one filewas used in the same manner until it has reached 2/3 of the estimated working length as indicated by the stopper on the instrument. The instrument is then removed from the canal; the canal was irrigated. This procedure was repeated until the instrument reached original working length.

Group II:

The ProTaper retreatment instruments (D1, D2, D3) (Dentsply, Maillefer) of which the tapers and tip diameters were equivalent to size 0.09/0.30mm, 0.08/0.25mm, and 0.07/0.020mm respectively were used sequentiallyfor removing gutta-percha from each root canal in a crown-down technique each filewere used as recommended by manufacturer then apical enlargement was performed with finishing file F2.

Group III:

The R-Endo instruments (R1, R2 and R3) (Micro-Mega, France) were used sequentially to remove gutta-percha and its sealer in abrushing circumferential movement as recommended bythe manufactures. The three instruments have the same tip size equivalent to no 25 but with different tapers; 0.08 for R1, 0.06 for R2, 0.04 for R3. R3 prepares the canal at 0.04 taper so the R2 file was used again to the full working length to establish the 0.06 taper. An HERO Shaper file no 25 (Micro Mega Besancon, France) was used as a finishing file to the full length of the canal.

Group IV:

The D – RaCere treatment instruments (DR1, DR2) (FKG Dentaire, Swiss Dental Products) of which the tapers and tip diameters were equivalent to size 10% ISO 30, 4% ISO 25 respectively were used sequentially in a crown-down technique for removing gutta-percha from each canal.Finalapical enlargement was performed with RaCe file size 25.

Removal of filling material was judged completed when no gutta-percha or sealer on the last instrument used andthe working length was reached.

Evaluation of Effective Gutta-Percha Removal:

All the roots were radiographed before and after removal of gutta-percha from both bucco-lingual and mesiodistal directions using custom made platform and digital radiograph system RVG to have a digitized image. Radiographic platform provided standardized position for periapical films, root blocks and x-ray cone. The source-film distance was adjusted to 18cm between X- ray source and the object and the exposure time was 0.12 sec.

The total surface area of all root canals were measured before removal of gutta-percha (figure. 1) and the area of the remaining gutta-percha filling in the canals after retreatment procedure (figure 2) from both directions. These measurements were analyzed with adobe Photoshop CS6 software and specific software tool (magnetic lasso)was used tooutline the total canal areaand the filling debris area(Fig 3).The software was calibrated to convert pixels into actual millimeter units. A measurement scale was made to have area in mm2.

The percentage of removed gutta-percha calculated by the following equations:

Area of removed gutta-percha= area of gutta-percha before removal – area of remnant gutta-percha after removal

Percent of gutta-percha removal=(area of removed gutta-percha/area of gutta-percha before removal)*100.

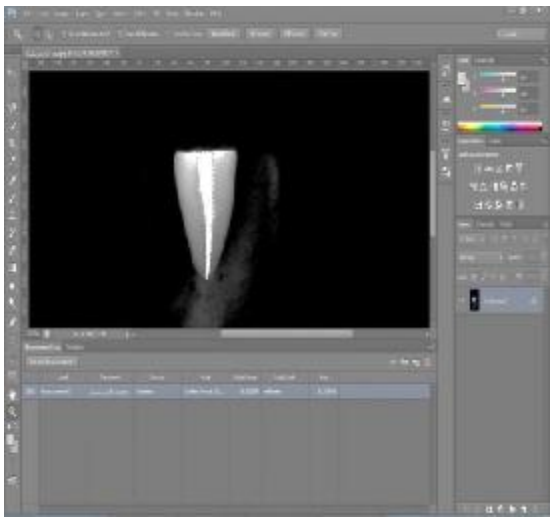

Figure 1: The Use of Adobe Photoshop CS6 Software and Magnetic Lasso Tool to Measure the Total Canal Area.

Figure 2: The Use of Adobe Photoshop CS6 Software and magnetic Lasso Tool to Measure the Area of the Remaining Filling Debris Area.

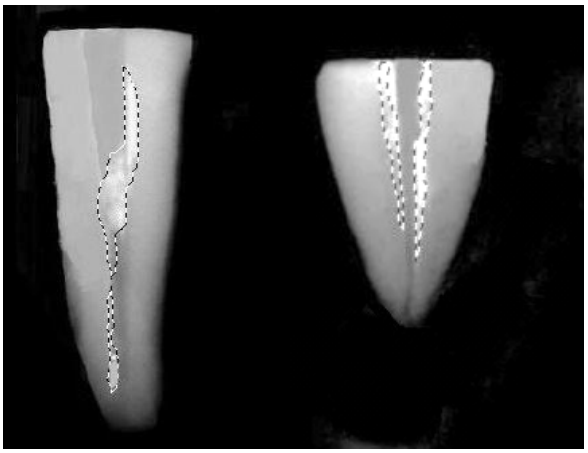

Figure 3: Radiograph to Trace Remaining Filling Material in Both Bucco-Lingual and Mesio-Distal Directions by the Use of magnetic Lasso Tool.

RESULTS

The present study showed the following results (table 1): in bucco-lingual direction, the highest and the lowest mean values for of the percentage of root canal filling removalwere seen at group I Wave One system (79.90) and group IV D–RaCe system (66.85) respectively. In mesiodistal direction, the highest and the lowest mean values for of the percentage of root canal filling removalwere seen at group I Wave One system (76.74) and group II ProTaper Retreatment system (64.46) respectively.The rest mean values for the study groups were fluctuating between these values.

To compare between the four retreatment systems ANOVA test and the least significance difference test (LSD) were performed to evaluate the significant differences between each two retreatment system for their effectiveness in removal of root canal filling materialsthe results showed the following, in bucco-lingual direction (table 2):

1- There were significant difference ($p \leq 0.05$) between group I (Wave One) and group II (ProTaper Retreatment), group IV (D – RaCe).
2- There was non-significant difference ($p \geq 0.05$) between group I (Wave One) and group III (R-Endo).
3- There were non significant difference ($p \geq 0.05$) between group II (ProTaper Retreatment) and group III (R-Endo), group IV (D – RaCe).
4- There were non significant difference ($p \geq 0.05$) between group III (R-Endo) and group IV (D – RaCe).

The results showed the following, in mesio-distal direction (table 2):

1- There were significant difference ($p \leq 0.05$) between group I (Wave One) and group II (ProTaper Retreatment) , group III (R-Endo).
2- There were non significant difference ($p \geq 0.05$) between group I (Wave One) and group IV (D – RaCe).
3- There were non significant difference ($p \geq 0.05$) between group II (ProTaper Retreatment) and group III (R-Endo), group IV (D – RaCe).
4- There were non significant difference ($p \geq 0.05$) between group III (R-Endo) and group IV (D – RaCe).

Table 1: Mean Value and Standard Deviation of Four Retreatment Techniques.

Studied groups	N	Bucco-lingual (BL)		Mesiodistal (MD)	
		Mean%	±SD	Mean%	±SD
Wave One	10	79.90	6.52	76.74	8.31
ProTaper Retreatment	10	71.48	12.33	64.46	9.73
R-Endo	10	74.01	11.82	66.46	11.32
D – RaCe	10	66.85	14.75	67.75	14.85

DISCUSSION

Nonsurgical endodontic retreatment was aimed to remove the contaminated filling material and the remnants pulp tissue or bacteria that might because the previous treatment to fail [18].

Success rates of nonsurgical endodontic retreatment were ranged from 40% to100% [19]. This variability might be related to different factors: the techniques that were used to remove the filling materials [20], the repairing possibility of pathologic or iatrogenic defects and the alterations in the natural course of the root

canals[21]. Removal of sealers and gutta-percha from

Table 2: The Least Significance Difference Test (LSD) of the Percentage of Root Canal Filling Removal between the Four Retreatment Techniques.

Studied groups		(LSD test) Bucco-lingual (BL)		(LSD test) Mesio-distal (MD)	
		p-value	Sig.	p-value	Sig.
Wave One	ProTaper	.028	S	.020	S
	R-Endo	.094	N.S	.050	S
	D – RaCe	.024	S	.084	N.S
Pro Taper	R-Endo	.579	N.S	.694	N.S
	D – RaCe	.942	N.S	.521	N.S
R-Endo	D – RaCe	.530	N.S	.802	N.S

***S =significant*N.S= non significant**

inadequately filled root canal systems was essential in root canal retreatment as it was unlikely to uncover remaining necrotic tissue or bacteria that might be the cause for periapical inflammation and post treatment disease [22].

A number of new endodontic materials hadbeen introduced in the last few years among them wasthe resin based sealer [23]. Despite the material wasacclaimed to have superior properties, regarding its adherence to the tooth structure, no obturation system yet claimedto have a 100% success rate and a number of reasons would necessitate the retreatment of filled teeth[24].

The present study evaluated the effectiveness of retreatmenttechniquesinremoval of gutta-percha and AH26 resin sealers.

All specimens were obturated using lateral condensation technique to condense ProTaper GP point (F2), as it showedbetter treatment outcome (prevent bacterial penetration of the root canal) than single ProTaper GP point which wasinaccordance with study performed by Yucel and Ciftci in 2006.

Retreatment solvents were notused in this study because the combined use of solvents androtary files complicatedthe debridementof the root canal, the solvents dissolved flowed into and coated canal irregularities or penetrated into the peri-radicular tissues [25].

Previous studies suggested that further root canal refining is necessary afterusing retreatment systemsbecause of the apical diameter of the last instrument was designed to reach the working length, but it did not permit a complete cleaning action [26]. In the present study finishing files were used at the end of the retreatment procedure forrotary instruments to properly enlarged the canal, F2, HERO Shaper file no 25 and RaCe file size 25 as recommended by the manufactures.

Reciprocating systems were an interesting alternative for removal of root fillings in retreatment cases. However, few studies had investigated the efficiency of reciprocating systems for emptying filled root canals [27].

The findings of the present study showed that the use of group I (Wave One) with reciprocating motion was more efficient in removal of root canal filling materials in both bucco-lingual and mesiodistal direction of dentalradiographthese results might be attributed to that Wave One file was used with reciprocating movement with unequal clockwise and counter clockwise rotation based on reverse balanced force technique [28]. These reciprocating movements caused engagement of the filling material with the first motion and dislodgment of the filling from the canals via the second motion.

The other retreatment systems used in the other groups with continuousrotation motion showed less efficiency in removing of root canal filling materials and these results vary according to difference in taper, design and cross section of each retreatment systems. Different methodologies had been used for the evaluation of the remaining filling material, in this study radiographic examination with computers software which were more appropriate than other methods such as longitudinal cleavage of the root which might cause displacement of the filling debris that was to be evaluated, which would compromise the accuracy of the measurements[29]. To overcome the limitation of the radiographic images that provided only two dimensional information, bucco-lingual and mesiodistal images were taken and evaluated for each root. This is in accordance with other studies [30].

Within the limitation of the present study remnants of filling material were observed in all samples regardless of the groups examined. Rotaryretreatment instrumentsused with continuous motion were not as effective in removing filling material remnants as the reciprocating instrument. The reciprocating technique was most effective method for removing gutta-percha and sealer than continuousrotary technique.

REFERENCES

1. Stabholtz A, Friedman S. Endodontic retreatment case selection and technique. Part 2: treatment planning for retreatment. J Endod1988; 14: 607–14.
2. Friedman S, Stabholtz A, Tamse A. Endodontic retreatment case selection and technique. Part 3: retreatment technique. J Endod1990; 16: 543–6.
3. Gorni FG, Gagliani MM .The outcome of endodontic retreatment: a 2-yr follow-up. J Endod 2004; 30:1–4.
4. Betti LV, Baramante CM. Quantec SC.Rotary instruments versus hand files for gutta-pecha removalin root canal retreatment. Int Endod J 2001; 34: 514-9.
5. Giuliani V, Cocchetti C, Pagavino G. Efficacy of protaper universal retreatment files in removing filling materials during retreatment. J Endod 2008; 34: 1381-4.
6. Baratto-Filho F, Ferreira EL, Fariniuk LF. Efficiency of the 0.04 taper ProFile during the re-treatment of gutta-percha-filled root canals. Int Endod J 2002; 35:651-4.
7. Sae-Lim V, Rajamanickam I, Lim BK, Lee HL. Effectiveness of ProFile .04 taper rotary instruments in endodontic retreatment. J Endod 2000; 26:100-104.
8. Wilcox LR, Krell KV, Madison S, Rittman B. Endodonticretreatment: Evaluation of gutta-percha and sealer removal andcanal reinstrumentation. J Endod1987; 13: 453-7.
9. Yared G .Canal preparation using only one Ni-Tirotary instrument: preliminary observations. Int Endod J 2008; 41: 339–44 (IVSL).
10. Kim HC, Kwak SW, Cheung GS, Ko DH, Chung SM, Lee W. Cyclic fatigue and torsional resistance of two new nickel-titanium instruments used in reciprocation motion: Reciproc versus WaveOne. J Endod 2002; 38: 541–4.
11. Alves FR, Rocas IN, Almeida BM, Neves MA, Zoffoli J, Siqueira JF Jr .Quantitative molecular and culture analyses of bacterial elimination in oval-shaped root canals by a single-file instrumentation technique. Int Endod J 2012; 45: 871–7.
12. Hulsmann M, Bluhm V. Efficacy, cleaning ability and safety of different rotary NiTi instruments in root canal retreatment. Int Endod J 2004; 37,468-76.
13. Ferreria JJ, Rhodes JS, Pitt Ford TR. The efficacy of guttapercha removal using Profiles. Int Endod J 2001; 34:267-74.
14. Masiero AV, Barletta FB. Effectiveness of different techniques for removing gutta-percha during retreatment. Int Endod J 2005; 38, 2-7
15. De Oliveira DP, Barbizam JVB, Trope M, Teixeira FB. Comparison between gutta-percha and resilon removal using two different techniques in endodontic retreatment. J Endod 2006; 32:362–4.
16. Giuliani V, Coccbetti R, Pagavino G. Efficacy of Protaper universal retreatment files in removing filling materials during root canal retreatment. J Endod 2008; 34: 1381-4.
17. Gergi R, Sabbagh C. Effictiveness of two nickel titanium rotary instruments and a hand files for removing guttapercha in severely curved root canals during retreatment :an ex vivo study. IntEndod J 2007; 40: 532-7.
18. Saad AY, Al-Hadlaq SM, Al-Katheeri NH .Efficacy of two rotary NiTi instruments in the removal of gutta-percha during root canal retreatment. J Endod 2007; 33: 38–41.
19. Paik S, Sechrist C, Torabinejad M. Levels of evidence for the outcome of endodontic retreatment. J Endod 2004; 30:745- 50.
20. Farzaneh M, Abitol S, Freidman S. Treatment outcome inendodontics: The Toronto study –phases I and II: orthograde retreatment. J Endod 2004; 30:627-33.
21. Masiero AV, Barletta FB. Effectiveness of different techniques for removing gutta-percha during retreatment. Int Endod J 2005; 38: 2-7.
22. Schirmeister JF, Hermanns P, Meyer KM, Goetz F , Hellwig E. Detectability of residual Epiphany and gutta-percha after root canal retreatment using a dental operating microscope andradiographs; an ex vivo study. Int Endod J 2006; 39: 558-65.
23. Monticelli F, Sword J, Martin G, Schuster GS, Weller RN, Ferrari M, Pashley DH, Tay FR. Sealing properties of two contemporary single cone obturation system. Int Endod J 2007; 40,374-385.
24. Yucel AC, Ciftçi A. Effects of different root canal obturation techniques on bacterial penetration. Oral Surg Oral Med Oral Pathol Oral Radiol Endod J 2006; 102(4): e88-92.
25. Horvath SD, Altenburgur MJ, Naumann M, Wolkewitz M, Schirrmeister JF. Cleanliness of dentinal tubules following gutta-percha with and without solvents: A scanning electron microscope study. Int Endod J 2009; 42:1032-8 (IVSL) .
26. Huang X, Ling J, GU L. Quantitive evaluation of debris extruded apically by using Protaper Universal Tulsa rotary system in endodontic retreatment. J Endod 2008; 33: 1102-5.
27. Masiero AV, Barletta FB. Effectiveness of different techniques for removing gutta-percha during retreatment. Int Endod J 2005; 38(1): 2–7.
28. Yvesblum J, Machtou P. Qualitative description of new preparation technique the balance force motion using endograph. J Endod 2001; 27:503-07.
29. Barletta FB, Lagranha SB. Analisiscomparativo in vitro de diferentestecnicas de desobturación de conductosradiculares. Endodoncia 2002; 20:189–96.
30. Gergi R, Sabbagh C. Effectiveness of two nickel titanium rotary instruments and a hand files for removing gutta-percha in severely curved root canals during retreatment :an ex vivo study. Int Endod J 2007; 40: 532-7.