

# Comparative Evaluation of Efficacy of ProTaper<sup>®</sup> Universal Rotary Retreatment System for Gutta-percha Removal from Single Root Canals, Obturated with Two Different Techniques: *In Vitro* Cone-beam Computed Tomography Study

Krishna P Lashkari<sup>1</sup>, Alka Shukla<sup>2</sup>, Chittinahalli N Vijay Kumar<sup>3</sup>, Gaurav Sharma<sup>4</sup>

## ABSTRACT

**Aim:** To compare and evaluate the efficacy of ProTaper<sup>®</sup> Universal retreatment system (URS) files in retrieval of gutta-percha (GP) from the canals obturated with two different obturation techniques, using cone-beam computed tomography (CBCT).

**Materials and methods:** Fifty-two extracted maxillary central incisors fulfilling inclusion criteria were decoronated and prepared with ProTaper<sup>®</sup> rotary files till F3 file size. Specimens were randomly divided into two groups and were obturated with GP. The first group was obturated with cold lateral condensation technique and second group was obturated with thermoplasticized GP technique. The root fillings were retrieved from the canals using ProTaper<sup>®</sup> URS files. Preoperative and postoperative CBCT imaging was employed to assess the residual filling material in the canals. ITK-Snap software was used to calculate volume of filling material in the canals. Data were entered into Microsoft excel worksheet and analyzed using Statistical Package for Social Sciences, version 18.0 (SPSS Inc., Chicago, IL, USA). Descriptive statistics with percentage mean and standard deviation was computed. Independent sample t test was used to test the difference between study groups.

**Results:** Residual root canal fillings were detected in all specimens. The mean volume percentage of remaining filling material was 10.69% ± 3.50 and 13.70% ± 3.63 in canals obturated with cold lateral condensation and thermoplasticized GP techniques, respectively.

**Conclusion:** This study concluded that though ProTaper<sup>®</sup> URS failed to remove GP completely, it was more efficient in the group of root canals obturated with cold lateral condensation than the canals obturated with thermoplasticized GP technique.

**Keywords:** Endodontic retreatment, Gutta-percha removal, ProTaper<sup>®</sup> Universal retreatment system, Thermoplasticized obturation.

*Conservative Dentistry and Endodontic Journal* (2019): 10.5005/jp-journals-10048-0048

## INTRODUCTION

Retaining natural dentition is the supreme goal of dentistry. In an attempt to fulfill this goal, retreatment of certain poorly obturated root canals is sometimes a necessity in endodontic practice. American Association of Endodontists (AAE) has defined retreatment as “the removal of root canal filling materials from the tooth, followed by cleaning, shaping, and obturating the canals. The terms “endodontic reintervention” and “endodontic revision” have also been employed for the same.<sup>1</sup>

Sometimes, even after thorough instrumentation, substantial amount of root canal filling material remains in the canal. This leftover may lead to compromised seal of the new root filling; therefore, previous filling should be removed completely.<sup>2</sup>

Various methods which have been advocated in the literature for retrieval of root canal fillings are the following: by using Hedstrom files (H-files), stainless steel K-files, heat carrying instruments, and engine-driven rotary instruments like peso reamers, Gates-Glidden drills, retreatment files, ultrasonic tips, and lasers.<sup>3-5</sup> Studies have shown that the use of rotary instrument for removal of filling material is safer and consumes lesser time than hand instruments.<sup>2,6,7</sup>

It has also been observed that rotary nickel-titanium (NiTi) instruments reduce operator's and patient's fatigue.<sup>8</sup> In endodontics, one of the most commonly used rotary systems is ProTaper<sup>®</sup> NiTi rotary file system, which has been upgraded to ProTaper<sup>®</sup> Universal retreatment system (ProTaper<sup>®</sup> URS; Dentsply/Maillefer, Ballaigues, Switzerland). It consists of shaping, finishing, and retreatment

<sup>1</sup>Department of Conservative Dentistry and Endodontics, KVG Dental College and Hospital, Sullia, Karnataka, India

<sup>2</sup>Department of Microbiology, Institute of Medical Sciences, Banaras Hindu University, Varanasi, Uttar Pradesh, India

<sup>3</sup>Department of Conservative Dentistry and Endodontics, Subbaiah Institute of Dental Science, Shivamogga, Karnataka, India

<sup>4</sup>Department of Public Health Dentistry, SCB Dental College and Hospital, Cuttack, Odisha, India

**Corresponding Author:** Alka Shukla, Department of Microbiology, Institute of Medical Sciences, Banaras Hindu University, Varanasi, Uttar Pradesh, India, Phone: +91 9919405299, e-mail: alka.rubygarg@gmail.com

**How to cite this article:** Lashkari KP, Shukla A, Kumar CNV, et al. Comparative Evaluation of Efficacy of ProTaper<sup>®</sup> Universal Rotary Retreatment System for Gutta-percha Removal from Single Root Canals, Obturated with Two Different Techniques: *In Vitro* Cone-beam Computed Tomography Study. *Cons Dent Endod J* 2019;4(2):30-33.

**Source of support:** Nil

**Conflict of interest:** None

instruments. Retreatment files are three in number and have various diameters at tip, different tapers, and lengths.<sup>6,8-10</sup>

There are various root canal filling materials like silver points, gutta-percha (GP), resilon, mineral trioxide aggregate (MTA), and paraformaldehyde pastes which are available.<sup>11</sup> Gutta-percha, along with sealers is frequently used material for root canal obturation. There are different techniques used to obturate root canals with GP.<sup>3</sup>

Clinician can adopt any technique which is more promising to him. Among diverse techniques available, cold lateral condensation is most frequently used. Along with conventional lateral condensation technique, thermoplasticized GP technique has also gained popularity in the recent times.<sup>2</sup> Therefore for the present study, these two techniques had been considered.

Majority of previous studies which have been performed to assess root canal fillings, were invasive in nature. Methods like sectioning the teeth and then examining the root canal surfaces for remaining GP causes damage to the specimen as well as loss of GP material during sectioning.<sup>2,7,12</sup> Other radiographic methods lacked in providing correct volumetric analysis of root filling material.<sup>13</sup> In such a scenario, cone-beam computed tomography (CBCT) is a technology which provides three-dimensional (3D) quantitative volume analysis of leftover root canal material and gives more accurate measurements. It is a nondestructive method which permits detailed visualization of the features without destruction of teeth.<sup>2,6</sup>

## MATERIALS AND METHODS

Fifty-two extracted intact permanent single-rooted maxillary central incisors were selected with fully formed apices. Radiographic evaluation was performed to confirm the patency of canals and to check for any possible internal resorption of teeth. The sample teeth were decoronated horizontally with a diamond disk (0.2 mm thickness) at the level of 2 mm coronal to cemento-enamel junction (CEJ). A size-15, K file was introduced into the canal till apical foramen. Initial hand instrumentation of each sample was carried out till size-25, K-file. Later the canals were prepared with 5 ProTaper® Universal rotary instruments in the sequence recommended by the manufacturer (S1, S2, F1, F2, and F3).

### Obturation of Prepared Root Canals

All sample teeth were marked starting with serial number 1–52 and were grouped into two groups of 26 each:

Group I ( $n = 26$ )—The sample teeth starting with serial no. 1 till 26 were obturated with 2% taper GP cones using cold lateral condensation technique.

Group II ( $n = 26$ )—The sample teeth starting with serial no. 27 till 52 were obturated using thermoplasticized injectable technique with Meta Biomed EQ plus “back fill” obturation system. Twenty-three gauze Meta Biomed needle was used to inject the thermoplasticized GP into the canals. As per manufacturer’s recommendation, the gun unit of Meta Biomed EQ plus obturation system was assembled and the temperature was set to 150° centigrade. Obturation of canals was carried out by inserting the tip of needle into the prepared canals, 3 mm short of working length, and then releasing the GP slowly into the canals. All the obturated specimens were sealed with temporary restoration (Cavit-G, 3M Espe, Seefeld, Germany) and were left at room temperature for 14 days to allow proper setting of filling material.

After 14 days, all teeth were subjected to CBCT machine (KODAK, 9300c, USA) for scanning. The scanned data were then

transferred to computer system and volume of obturated material was calculated by employing ITKsnap software.

### Retreatment Procedure

ProTaper® URS files were used applying crown-down technique. These files were used in a sequential order of D1, D2, and D3 at a constant speed of 500 revolutions per minute with a torque of 3 Newton centimeters (N cm). Procedure was assumed to be complete when no obturated material was seen on the retreatment files.

Again all the specimens were subjected to CBCT scanning and data were transferred to computer system. Volume of remaining filling material in the canal was calculated using ITK-Snap software and recorded. The data collected were analyzed using Statistical Package for Social Sciences, version 18.0 (SPSS Inc., Chicago, IL, USA). Descriptive statistics with percentage mean and standard deviation was computed. Independent sample *t* test was used to test the difference between study groups. A *p* value of <0.05 was considered as significant.

## RESULTS

Preoperative and postoperative values obtained from CBCT scanning were recorded and percentage of volume of remaining root canal filling material was calculated. The percentage of residual root canal filling material was calculated by using the following formula (Table 1):

$$\text{Residual volume percentage} = \frac{\text{Volume of remaining filling material}}{\text{Volume of original filling material}} \times 100$$

## DISCUSSION

In spite of performing good root canal treatment, failure rate of this treatment is around 8%.<sup>14</sup> Under circumstances of failure of endodontic therapy, endodontist can opt and proceed with one of the following options: nonsurgical orthograde retreatment therapy, surgical endodontic therapy, and combined therapy consisting of both nonsurgical and surgical treatment.<sup>15</sup> Most of the time, nonsurgical retreatment is preferred by patient as well as endodontist.<sup>7,16</sup>

Reestablishment of correct working length and decontamination of root canals completely is a crucial step in root canal retreatment.<sup>17</sup> But in spite of recent advances in endodontics, many studies have reported the presence of substantial amount of residual root canal filling material in the canals after instrumentation.<sup>18–20</sup> Therefore, the goal of retreatment shifts from complete retrieval to maximum retrieval of old filling.

Previous studies have concluded that rotary instruments are safer and take lesser time than conventional hand instruments, and it also reduces clinician’s fatigue.<sup>12,21–23</sup> Therefore, to contribute to the aforementioned data on rotary retreatment files, the present study on efficacy of one of the rotary retreatment files was formulated.

**Table 1:** Comparison of mean residual volume percentage (MRVP) of root canal filling material after retrieval in two different groups

Condensation technique	Number of teeth (n)	Mean	Standard deviation	Mean difference	Student t test (T)	p value
Cold lateral condensation	26	10.69	3.50	3.0	3.04	0.004
Thermoplasticized GP	26	13.70	3.63			

Previous investigations have employed variety of methods to calculate remaining root canal filling material in the canals after retreatment. These methods were radiographic examination, stereomicroscope evaluation, scanning electron microscopy, and CBCT, taking digital images after splitting teeth longitudinally, clearing techniques and micro-CT.<sup>2,7,13</sup> Radiographic images of sample provide only two-dimensional (2D) information of a 3D structure. Radiographs may be subjected to magnification and distortion.<sup>24</sup> Digital imaging technique results in loss of residual filling material during splitting of teeth longitudinally. To date, micro-CT represents the most precise method for this evaluation but it is extremely time-consuming. Therefore, 3D CBCT imaging, which is more promising and readily available to researchers, was adopted for present study to evaluate residual root canal filling material.<sup>23</sup> Though CBCT has its own limitations like streaking image artifacts in obturated root canals due to beam hardening effect,<sup>25</sup> it did not hinder the volume calculation; thus, the results of this study were not affected much.

Among the available variety of rotary retreatment files, ProTaper® Universal retreatment system (ProTaper® URS; Dentsply/Maillefer, Ballaigues, Switzerland) files have been proven to be one of the most popular and commonly used systems currently available in market.<sup>26</sup> The initial preparation of specimen teeth was carried out with ProTaper® rotary files; therefore for subsequent retreatment, ProTaper® URS was selected. Iriboz et al. carried out an *in vitro* research to compare efficacy of ProTaper® URS and Mtwo retreatment system and concluded that ProTaper® URS was superior to Mtwo retreatment system.<sup>27</sup> Studies performed by Siotia et al., Soares et al. have studied efficacy of ProTaper® URS in removing different root canal filling materials, resilon, and GP from the canals during retreatment and found out positive results.<sup>28,29</sup> Topcuoglu et al. had compared cyclic fatigue resistance of D-RaCe and ProTaper® URS files and found out that the canals with 45° of curvature showed no significant difference between both the retreatment systems.<sup>16</sup>

Present study demonstrated that it was difficult to retrieve obturated material thoroughly from the canals. Findings of this study are in accordance with previously performed studies.<sup>2,4,6,9</sup> In a previous publication, it was stated that ProTaper® URS leaves around 10–35% of root canal fillings in the canals after their use.<sup>23</sup> This study confirmed the above-mentioned data by presenting a mean value of residual volume 10.69% and 13.7% in groups I and II, respectively (Fig. 1). There was statistically significant variation among groups I and II with a *p* value being 0.004. To some extent, compromised retrieval property of ProTaper® URS can be attributed to dimensions of retreatment files.<sup>2,23</sup> ProTaper® URS is a set of three Ni-Ti rotary files which are labeled as D1, D2, and D3. Apical size, taper, and length of these files vary as follows: D1—30/0.09, 16 mm; D2—25/0.08, 18 mm; and D3—20/0.07, 22 mm. These files have a convex, triangular cross section, and D1 has an active working tip which assists its penetration into obturated canals. These files should be used in recommended sequential order which is D1, D2 and D3. Apical size and taper of the last file to be used (D3 file) is 20/0.07, and in the present study, the preparation of the apical part of the canal was carried out with finishing file F3 which has apical size and taper 30/0.09. Because of difference between dimensions of retreatment file and prepared canal, there is possibility that file could not engage the root filling material completely and failed to retrieve it. To obtain favorable results, reinstrumentation at working length with an instrument larger in size than the one used for primary treatment is necessary.<sup>2</sup>

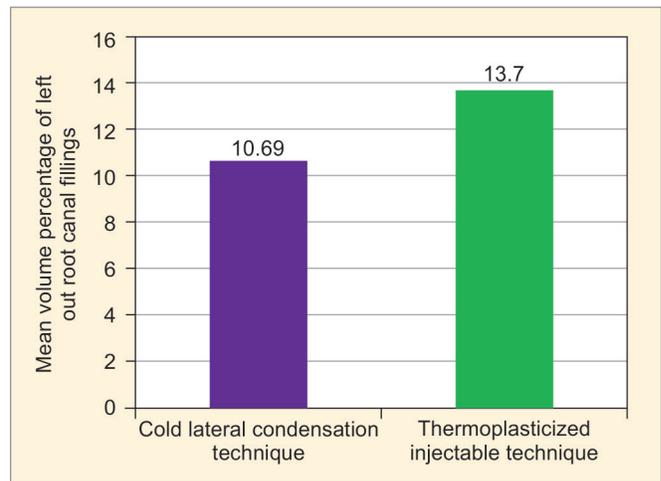


Fig. 1: Mean residual volume percentage of root canal filling material in the canals after using retreatment files

A potential reason for gaining much more percentage of root filling material residues in warm thermoplasticized group than the other group can be drawn out from the following findings:

- Thermoplasticized GP when inserted in the canals is in alpha ( $\alpha$ ) phase. This phase of GP is more plastic in nature and thus can flow in small irregularities and dentinal tubules of the canals leading to a better seal of GP to the root canal walls.<sup>23,30–32</sup>
- Thermoplasticized GP which gets wedged into irregularities of dentin cannot be easily removed.
- It has been reported that thermoplasticized GP technique resulted in an obturation with greater density.<sup>2</sup>
- During obturation, warm GP produces deeper penetration of sealer into tubules which again leads to superior seal formation when compared to cold GP compaction.<sup>33</sup>
- In cold lateral condensation technique, the filling does not consist of homogeneous mass of GP. The final root canal filling is composed of many GP cones tightly compacted together, joined by tight frictional grip and sealer cements. The accessory and master cones are laminated because of which it remain separate.<sup>2</sup>
- In cold lateral condensation technique, GP is in beta ( $\beta$ ) phase. GP in this phase cannot be compressed at room temperature. Therefore, accessory anatomy of canal like fins, isthmus, and apical deltas cannot be reached out and thus results in compromised seal when compared to warm GP compaction.<sup>32</sup>

## CONCLUSION

Following inferences can be concluded:

- ProTaper® URS did not remove root canal fillings thoroughly from either of the two sets of obturated canals. Thus, removal of root canal fillings should be clubbed with other techniques like photon-initiated photoacoustic streaming (PIPS) and passive ultrasonic irrigation (PUI) to get better results.<sup>34,35</sup>
- ProTaper® URS was more efficient in removing GP from the canals obturated with cold lateral condensation technique when compared to warm thermoplasticized GP technique.

The findings of this *in vitro* study have to be correlated with the clinical cases, and for more precise results, more *in vivo* studies must be conducted.

## REFERENCES

- Cunha RS, Silveira Bueno CE. Endodontic irrigation. Disinfection in nonsurgical retreatment cases. Switzerland: Springer International Publishers; 2015.
- Jingzhi M, Ahmed JA, Shen Y, et al. Efficacy of ProTaper universal rotary retreatment system for gutta-percha removal from oval root canals: a micro-computed tomography study. *J Endod* 2012;38(11):1516–1519. DOI: 10.1016/j.joen.2012.08.001.
- Bharathi G, Chacko Y, Lakshminarayanan L. An *in-vitro* analysis of gutta-percha removal using three different techniques. *Endodontology* 2002;14:41–45.
- Gu LS, Ling JQ, Wei X, et al. Efficacy of ProTaper Universal rotary retreatment system for gutta-percha removal from root canals. *Int Endod J* 2008;41(4):288–295. DOI: 10.1111/j.1365-2591.2007.01350.x.
- Keleş A, Arslan H, Kamalak A, et al. Removal of filling materials from oval-shaped canals using laser irradiation: micro-computed tomographic study. *J Endod* 2015;41(2):219–224. DOI: 10.1016/j.joen.2014.09.026.
- Hammad M, Qualtrough A, Silikas N. Three-dimensional Evaluation of Effectiveness of Hand and Rotary Instrumentation for Retreatment of canals filled with different materials. *J Endod* 2008;34(11):1370–1373. DOI: 10.1016/j.joen.2008.07.024.
- Marfisi K, Mercadé M, Plotino G, et al. Efficacy of Reciproc® and Profile® instruments in the removal of gutta-percha from straight and curved root canals *ex vivo*. *J Oral Maxillofac Res* 2015;6(3):e1. DOI: 10.5037/jomr.2015.6301.
- Colaco AS, Pai VAR. Comparative evaluation of the efficiency of manual and rotary gutta-percha removal techniques. *J Endod* 2015;41(11):1871–1874. DOI: 10.1016/j.joen.2015.07.012.
- Rodig T, Hausdorfer T, Konietschke F, et al. Efficacy of D-RaCe and ProTaper Universal retreatment NiTi instruments and hand files in removing gutta-percha from curved root canals- a micro-computed tomography study. *Int Endod J* 2012;45(6):580–589. DOI: 10.1111/j.1365-2591.2012.02014.x.
- Takahashi CM, Cunha RS, de Martin AS, et al. *In vitro* evaluation of the effectiveness of ProTaper Universal rotary retreatment system for gutta-percha removal with or without a solvent. *J Endod* 2009;35(11):1580–1583. DOI: 10.1016/j.joen.2009.07.015.
- Johnson JD. *Ingle's Endodontics. Root Canal Filling Materials*, 6th ed., Hamilton, Ontario: BC Decker Inc; 2008.
- Schirmeister JF, Wrbas KT, Meyer KM, et al. Efficacy of different rotary instruments for gutta-percha removal in root canal retreatment. *J Endod* 2006;32(5):469–472. DOI: 10.1016/j.joen.2005.10.052.
- 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(7):532–537. DOI: 10.1111/j.1365-2591.2007.01254.x.
- Marques da Silva B, Baratto-Filho F, et al. Effectiveness of ProTaper, D-RaCe, and Mtwo retreatment files with and without supplementary instruments in the removal of root canal filling material. *Int Endod J* 2012;45(10):927–932. DOI: 10.1111/j.1365-2591.2012.02051.x.
- Akbulut MB, Akman M, Terlemez A, et al. Efficacy of twisted file adaptive, reciproc and ProTaper Universal retreatment instruments for root-canal-filling removal: a cone-beam computed tomography study. *Dent Mater J* 2016;35(1):126–131. DOI: 10.4012/dmj.2015-214.
- Topcuoglu HS, Topcuoglu G, Akti A. Comparative evaluation of cyclic fatigue resistance of D-RaCe and ProTaper retreatment instruments in curved artificial canals. *Int Endod J* 2016;49(6):604–609. DOI: 10.1111/iej.12488.
- Ørstavik D, Pitt Ford TR. *Essential endodontology: prevention and treatment of apical periodontitis*. Oxford, UK, Malden, MA: Blackwell Science; 1998.
- Kanaparthi A, Kanaparthi R. The comparative efficacy of different files in the removal of different sealers in simulated root canal retreatment-an *in-vitro* study. *J Clin Diagn Res* 2016;10(5):130–133. DOI: 10.7860/JCDR/2016/17731.7845.
- Barone C, Dao TT, Basrani BB, et al. Treatment outcome in endodontics: the Toronto study—phases 3, 4, and 5: apical surgery. *J Endod* 2010;36(1):28–35. DOI: 10.1016/j.joen.2009.09.001.
- Haapasalo M, Shen Y, Ricucci D. Reasons for persistent and emerging post-treatment endodontic disease. *Endod Topics* 2008;18(1):31–50. DOI: 10.1111/j.1601-1546.2011.00256.x.
- Hülsmann M, Bluhm V. Efficacy, cleaning ability and safety of different rotary NiTi instruments in root canal retreatment. *Int Endod J* 2004;37(7):468–476. DOI: 10.1111/j.1365-2591.2004.00823.x.
- Giuliani V, Cocchetti R, Pagavino G. Efficacy of ProTaper Universal retreatment files in removing filling materials during root canal retreatment. *J Endod* 2008;34(11):1381–1384. DOI: 10.1016/j.joen.2008.08.002.
- Pawar AM, Thakur B, Metzger Z, et al. The efficacy of the Self-Adjusting File versus WaveOne in removal of root filling residue that remains in oval canals after the use of ProTaper retreatment files: a cone-beam computed tomography study. *J Conserv Dent* 2016;19(1):72–76. DOI: 10.4103/0972-0707.173204.
- Unal GC, Kaya BU, Taç AG, et al. A comparison of the efficacy of conventional and new retreatment instruments to remove gutta-percha in curved root canals: an *ex vivo* study. *Int Endod J* 2009;42(4):344–350. DOI: 10.1111/j.1365-2591.2008.01518.x.
- Brito-Júnior M, Santos LA, Faria-e-Silva AL, et al. *Ex vivo* evaluation of artifacts mimicking fracture lines on cone-beam computed tomography produced by different root canal sealers. *Int Endod J* 2014;47(1):26–31. DOI: 10.1111/iej.12121.
- Kasam S, Mariswamy AB. Efficacy of different methods for removing root canal filling material in retreatment—an *in-vitro* study. *J Clin Diagn Res* 2016;10(6):6–10. DOI: 10.7860/JCDR/2016/17395.7904.
- Iriboz E, Övecog HS. Comparison of ProTaper and Mtwo retreatment systems in the removal of resin-based root canal obturation materials during retreatment. *Aust Endod J* 2014;40(1):6–11. DOI: 10.1111/aej.12011.
- Siotia J, Acharya SR, Gupta SK. Efficacy of ProTaper retreatment system in root canals obturated with gutta-percha using two different sealers and guttaflow. *Int J Dent* 2011;2011:676128. DOI: 10.1155/2011/676128.
- Soares C, Maia C, Vale F, et al. Comparison of endodontic retreatment in teeth obturated with resilon or gutta-percha: a review of literature. *Iran Endod J* 2015;10(4):221–225.
- Frantzeska K, Christopoulos D, Chondrokoukis P. Gutta-percha and updated obturating techniques. *J Dent Health Oral Disord Ther* 2017;8(2):00276. DOI: 10.15406/jdhodt.2017.08.00276.
- Vishwanath V, Rao HM. Gutta-percha in endodontics—a comprehensive review of material science. *J Conserv Dent* 2019;22(3):216–222. DOI: 10.4103/JCD.JCD\_420\_18.
- Johnson WT, Kulild JC. *Pathways of the pulp. Obturation of the cleaned and shaped root canal system*, 10th ed., St Louis, Missouri: Mosby Inc; 2011.
- Canakci BC, Sungur R, Er O. Comparison of warm vertical compaction and cold lateral condensation of  $\alpha$ ,  $\beta$  gutta-percha and resilon on apically extruded debris during retreatment. *Niger J Clin Pract* 2019;22(7):926–931. DOI: 10.4103/njcp.njcp\_663\_18.
- Suk M, Bago I, Katić M, et al. The efficacy of photon-initiated photoacoustic streaming in the removal of calcium silicate-based filling remnants from the root canal after rotary retreatment. *Lasers Med Sci* 2017;32(9):2055–2062. DOI: 10.1007/s10103-017-2325-4.
- Nguyen TA, Kim Y, Kim E, et al. Comparison of the efficacy of different techniques for the removal of root canal filling material in artificial teeth: a micro-computed tomography study. *J Clin Med* 2019;8(7):984. DOI: 10.3390/jcm8070984.