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ORIGINAL RESEARCH

An Evaluation of GuttaFlow2 in Filling Artificial Internal Resorption Cavities: An *in vitro* Study

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ABSTRACT

Introduction: Obturation of root canal with internal resorption represents a major challenge in Endodontics. In spite of that, usual obturation techniques are often employed without considering the best technique to solve this problem. The goal of this study was to investigate the ability of GuttaFlow2 in filling artificial internal resorption cavities.

Materials and methods: The study sample included 36 human upper central incisors that were prepared using Protaper system (F4). Internal resorption cavities were prepared by cutting each tooth at 7 mm from the apex and preparing hemispherical cavities on both the sides and then re-attaching them. The sample was randomly separated into three groups (n = 12 in each group). In the first group, thermal injection technique (Obtura II) was employed and served as the control group. In the second group, injection of cold free-flow obturation technique with a master cone (GF2-C) was employed, whereas in the third group injection of cold free-flow obturation without a master cone (GF2) was followed. The teeth were re-cut at the same level as before and examined under a stereomicroscope. Subsequently, the captured images were transferred to AutoCAD program to measure the percentage of total filling “TF,” gutta-percha “G,” sealer “S,” and voids “V” out of the total surface of the cross sections.

Results: All materials showed high filling properties in terms of “total filling,” ranging from 99.17% (for Obtura II) to 99.72% (for GF2-C). Regarding gutta-percha percentages of filling, they ranged from 83.15 to 83.93%, whereas those for the sealer ranged from 5.71 to 15.24%. GuttaFlow2 group with a master cone appeared to give the best results despite the insignificant differences among the three groups.

Conclusion: The GuttaFlow2 with a master cone technique seemed to be a promising filling material and gave results similar to those observed with Obtura II. It is recommended for use to obturate internal resorption cavities in clinical practice due to its good adaptability to root canal walls, ease of handling, and application.

Clinical significance: Internal resorption defects can be successfully filled with GuttaFlow2 material when supplemented with a master cone, and the results are comparable with those obtained with the Obtura II technique.

Keywords: GuttaFlow2, Internal resorption, Obtura II, Obturation techniques.

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INTRODUCTION

Root resorption is the loss of dental hard tissues as a result of clastic activities.[1] It might occur as a physiologic or pathologic phenomenon, and is broadly classified into external and internal resorption by the location of the resorption in relation to the root surface.[2,3] Internal root resorption has been reported as early as 1830.[4] It is more frequently observed in male than in female subjects.[5,6] It is very common to detect internal resorption defects at the middle portion of the roots of the maxillary central incisors.[6] Irregular resorptive defects in the root canal make these areas inaccessible with normal methods of cleaning and shaping as well as obturation.[7] The prolonged presence of debris and bacteria in these areas may interfere with the long-term success of the endodontic treatment.[8] Therefore, the importance of achieving total obliteration of the root canal space has been stressed in case of internal resorption.[9]

Many techniques and materials have been evaluated in “*ex vivo*” study designs in order to examine their abilities to fill internal resorption defects. Gutmann et al[10] suggested the use of the Thermafil obturation technique; while Agarwal et al[7] reported that the use of ultrasonic measurements to condense the gutta-percha and the Obtura II system were superior to the Thermafil and lateral compaction techniques. Collins et al[11] suggested the use of warm lateral and warm vertical condensation gutta-percha techniques for such cases.

One of the recent techniques utilizing thermoplasticized gutta-percha is Obtura II, which is an injectable and heated gutta-percha technique that has been documented to be significantly better than lateral condensation.[12] Very recently, a cold free-flow obturation technique was introduced, and according to the manufacturer GuttaFlow2 has excellent flow properties because of its reduced viscosity under shear stresses.[13] This material flows into lateral canals and since no heat is required for its placement, no shrinkage is believed to occur.[13]

Therefore, the objectives of this study was to investigate the quality of root fillings by measuring the total filling (TF), the percentage of the sealer (S), and gutta-percha (G) components of the filling in relation to the total area of the cross-sectioned canal as well as the ratio of the residual voids (V) within the filled canal. This will be performed using artificially made internal resorption areas in root canals of extracted teeth using three fillings: Obtura II, GuttaFlow2 with a master cone (GF2-C), and GuttaFlow2 without a master cone (GF2).

MATERIALS AND METHODS

Thirty-six maxillary central incisors teeth were selected and adjusted to a length of 19 mm using a diamond disk® (Horico, Berlin, Germany). A conventional endodontic access was prepared in each tooth and a size 10-K file was inserted to determine the location of the apical foramen. The working length was determined 0.5 mm shorter than this measurement. Following the use of hand filing and after creating a glide path, ProTaper® files (Dentsply Maillefer, Ballaigues, Switzerland) were employed. The manufacturer's instructions were followed in the cleaning and shaping of the canals, until the research achieved the F4 file. During this procedure, 1 mL of 2.5% sodium hypochlorite was used as an irrigant between each step. Finally, all the canals of the teeth received a strong rinse of 1 mL 17% EDTA, followed by 5 mL 2.5% NaOCl to make sure that any residual layer was removed.[14]

To create artificial internal resorption cavities, the roots were sectioned horizontally with a fine diamond disk at a 7-mm distance from the apex. Semi-circular cavities were created using a low speed no. 6 round diamond bur around the boundaries of the aperture of the root canal of each section.[8,15] Then the sections were cemented together using Peligomglue® (Pelikan cyanoacrylate adhesive; Istanbul, Turkey) on the dentin surface around the cavities (Fig. 1). Care was taken to maintain the patency of the canal by using minimal amount of glue and file 40# inserted to the working length after gluing. Each tooth was embedded in a silicon model. Then, the sample was randomly assigned to three groups with 12 teeth in each group using a software-generated random numbers.

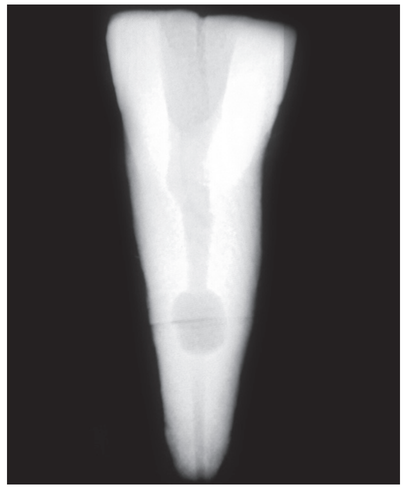

Fig. 1: A radiograph image for the artificial internal resorption cavity

The Control Group: Obtura II Group

AHplus® sealer (Dentsply-Maillefer, Ballaigues, Switzerland) was employed in this study to be inserted into the canals using Lentulo-spiral by the principal researcher. The Obtura II™ system (Obtura Spartan, Fenton, Missouri, USA) was used with respect to the manufacturer's guidelines. All obturation were handled with injection needles of the size of 23 gauges.[16]

The procedure of obturation included the injection of the filling material twice. In the first step, the insertion of the needle was stopped once it bound to the periphery of the canal and the thermoplasticized gutta-percha was injected. The temperature of this material was 185°C, according to the manufacturer's instructions. The injection was followed by vertical condensation of the softened material in the apical segment of the canal using a manual plugger (Dentsply Maillefer, Ballaigues, Switzerland). In order to achieve smooth plugging, the tip of the plugger was dipped in alcohol before being used. Back-filling of the residual portions of the canal was undertaken gradually until gutta-percha was seen at the canal orifice (Fig. 2).

Experimental Group: GuttaFlow2 with a Master Cone (GF2_C)

The same sealer in the control group was used. Following the manufacturer's instructions, the researcher inserted

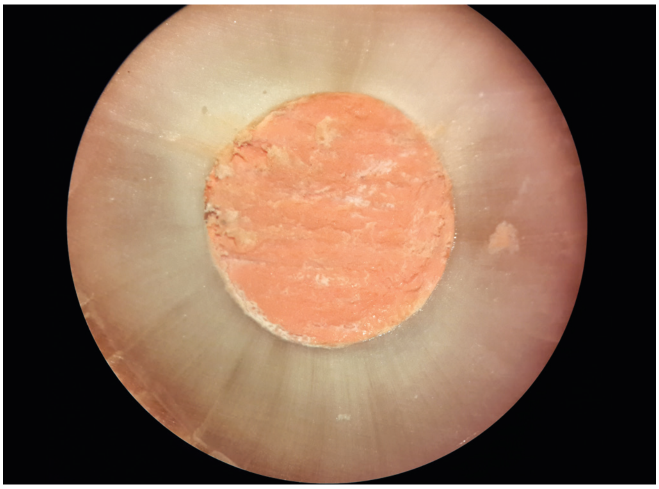

Fig. 2: A stereomicroscopic view of the internal resorption cavity filled using the Obtura II technique

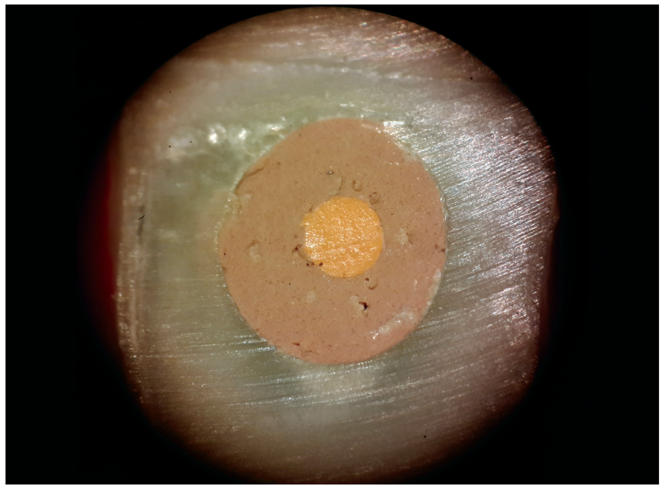

Fig. 3: A stereomicroscopic view of the internal resorption cavity filled using GuttaFlow2 with a master cone

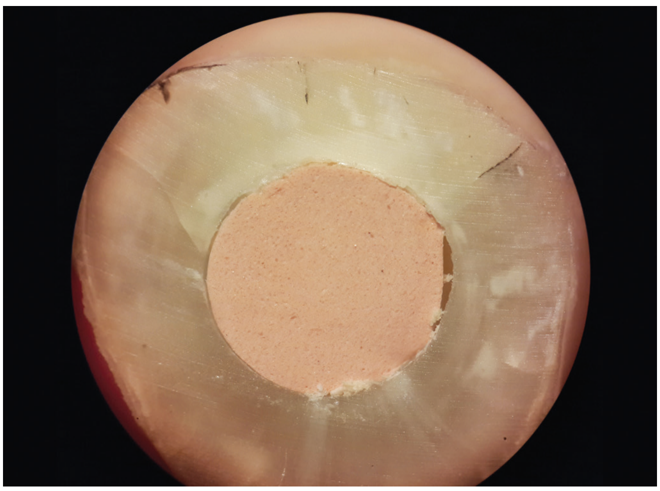

Fig. 4: A stereomicroscopic view of the internal resorption cavity filled using GuttaFlow2 without master cone

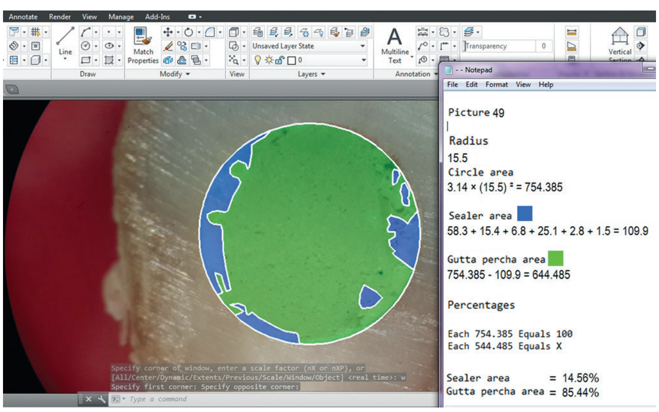

Fig. 5: Calculation of percentages of the four variables using AutoCAD© program

the plastic tip into the canal until it was felt that it could not be pushed further and deeper. The first point of filling was allocated at 3 mm above the established length. A master cone coated by GF2 was employed here to be inserted into canal using the allocated working length. Back filling of the GF2 material was undertaken until the material was seen at the orifice of the canal (Fig. 3).

Experimental Group: GuttaFlow2 without a Master Cone (GF2)

The same sealer in the control group was used. Following the manufacturer's instructions, the same procedures mentioned before were undertaken, with only one difference that a master cone of standardized guttapercha was not employed here (Fig. 4).

Following filling, the teeth were stored for 7 days at room temperature to ensure all materials had set. The silicone model was removed (Fig. 2). Then, each tooth was sectioned with a rotary saw 7 mm from the apex at the level of the previous cut, and under cold water to minimize gutta-percha smearing. Photographs of both surfaces of the sectioned area were taken by using a Nikon® Coolpix S2900 digital camera (Nikon, Tokyo, Japan), which was mounted on a stereomicroscope ocular eye. The photographs were transferred to a computer and an image analysis program (AutoCAD Architecture2014-Autodex,USA) was used to calculate the percentage of whole filling (i.e., the total filling "TF"), the sealer "S", the gutta-percha "G" and the residual voids "V" in relation to total surface area of the cross-sectioned canal (Fig. 5).

Statistical Analysis

Statistical analysis was performed using Statistical Package for the Social Sciences (SPSS®) version 21 (IBM SPSS, USA). One-way analysis of variance (ANOVA) was used to detect significant differences between the compared groups.

RESULTS

Descriptive statistics of the studied groups (n = 36 with 12 in each group) are given in Table 1.

Table 1: Descriptive statistics of the studied groups (n = 36 with 12 internal resorption cavities in each group)

Variable	*Group*	*Mean*	*SE Mean**	*SD*	*Q1*	*Median*	*Q3*	*Min*	*Max*	*IQR*
Total filling (TF)	Obtura II	99.17	0.59	2.04	99.25	100.00	100.00	93.00	100.00	0.75
	GuttaFlow2	99.40	0.23	0.79	98.78	99.84	100.00	97.62	100.00	1.22
	GuttaFlow2_ with master cone	99.72	0.10	0.36	99.45	99.81	100.00	98.90	100.00	0.56
Gutta-percha (GP)	Obtura II	83.93	5.46	18.92	72.50	91.50	99.00	42.96	100.00	26.50
	GuttaFlow2	83.15	3.84	13.29	71.50	86.16	93.69	59.11	97.73	22.19
	GuttaFlow2_ with master cone	94.00	1.46	5.07	90.65	96.18	97.85	84.15	98.77	7.20
Sealer (S)	Obtura II	15.24	5.09	17.64	1.00	8.50	27.50	0.00	50.04	26.50
	GuttaFlow2	15.92	3.92	13.59	5.33	12.40	27.68	0.80	40.89	22.35
	GuttaFlow2_ with master cone	5.71	1.48	5.14	1.59	3.70	9.29	1.20	15.52	7.70
Voids (V)	Obtura II	0.83	0.59	2.04	0.00	0.00	0.75	0.00	7.00	0.75
	GuttaFlow2	0.93	0.36	1.23	0.00	0.55	1.43	0.00	4.00	1.43
	GuttaFlow2_ with master cone	0.29	0.11	0.36	0.00	0.19	0.59	0.00	1.10	0.59

*SE: Standard error of the mean; SD: Standard deviation; Q1: First quartile; Q3: Third quartile; Min: Minimum value; Max: Maximum value; IQR: Interquartile range.

Table 2: The results of comparing the three groups in terms of total filling, gutta-percha, sealer, and voids percentages*

Variable	*Obtura II*	*GuttaFlow2*	*GuttaFlow2– with master cone*	*f-value*	*p-value*
Total filling (TF)	99.17	99.40	99.72	0.56	0.579
Gutta-percha (Gp)	83.93	83.15	94.00	2.35	0.111
Sealer (S)	15.24	15.92	5.71	2.24	0.122
Voids (V)	0.83	0.93	0.29	0.75	0.482

*Employing one-way ANOVA

In general, very high percentages of total filling were observed in the Obtura II group (i.e., the control group) as well as in the GF2 groups, whereas the (GF2-C) group had the highest percentage of "TF" and this was accompanied with the lowest percentages of the sealer and voids compared to the other two groups. However, the differences observed were not statistically significant in all the comparisons (Table 2).

DISCUSSION

The difficult anatomy of the root canals, the irregularities resulting from pathological mechanisms, such as internal resorption, makes the obturation a complex process with a need for a high amount of accuracy. The search for a permanent filling material and a filling system to thoroughly obturate the affected areas by resorption is critically demanded.[6]

The difficulties arise in cleaning and shaping as well as obturation of the resorbed areas. In addition, these defects cannot be easily evaluated in traditional radiography. In a clinical setup, radiographs are only possible in the buccolingual view, whereas irregularities may be more visible in mesiodistal view.[8] Stereomicroscopic analysis was selected for this research project as this offers a clearer view of the surface to be examined by image analysis program.[17] Maxillary central incisors were the teeth of choice and the simulated internal resorption cavities were fabricated at the middle third of the roots according to previous publications, which have shown that these have been the most prevalent teeth and areas for internal resorption.[18] In addition, upper central incisors are the most teeth exposed to dental trauma since these erupt first and they are located in the front of the upper jaw.[19]

In this study, we selected three techniques in filling of artificial internal resorption cavities. One of them was Obtura II™, which is an injectable and thermoplasticized technique. The other material was GuttaFlow2, which is a new root canal obturation material at room temperature. In the current study, it was used in two different ways, that is, with or without a master cone.

Based on the results of this study, the three methods have shown good results and high filling ratios for artificial internal resorption, that is, 99.17% and above, with a noticeable superiority of the GuttaFlow2 with a master cone technique, which showed the highest percentage of total filling (99.71%) and gutta-percha (94%) and the lowest percentages of the sealer (5.71%) and the remaining voids (0.29%). However, the observed differences among the three groups were insignificant for the four variables under evaluation. Therefore, GuttaFlow2 with a master cone technique seemed to be a promising filling material and gave results similar to those observed with Obtura II.

Many researchers have tried to compare different techniques and materials to investigate the best technique capable of filling resorption defects. Goldberg et al[8] noted that the best results for filling artificial internal resorption cavities were when they used the Obtura II gun, and the lowest frequency of total obturation was observed when the lateral compaction technique was used. Agarwal et al.[7] noted that the results with Thermafil® and lateral condensation were inferior compared to Obtura II and ultrasonic condensation technique for obturation of internal resorption cavities. Gencoglu et al[20] also noted that warm gutta techniques (Microseal technique filled 99%) filled artificial resorption cavities significantly better than the other gutta-percha techniques, such as LC (92%), SystemB (89%), Quick-Fill (88%), Thermafil (74%), and Soft-Core (73%). Both Stamos and Stamos[21] and Wilson and Barnes[22] have shown good results radiographically when using the Obtura system, combined with vertical compaction in the obturation of root canals with internal resorption.

Most studies have confirmed the superiority of Obtura in achieving appropriate filling of the internal resorption cavities, and noted that the obturation of the root canal should contain more gutta-percha and less sealer, because some sealers may shrink or undergo dissolution.[23,24] This is particularly important when filling root canals with perforating resorption lacunas.[7]

In the current study, the observed nonsignificant superiority of the GuttaFlow2 with a master cone technique may be due to the flowability and increased wettability of gutta-percha in the (GF2-C) group and the documented expansion of this material on setting.[16,25,26] The small difference between the two GuttaFlow2 groups could be attributed to the role of the main cone, which was coated by GuttaFlow2 following its injection into the canal, in addition to inserting this cone to its total working length.

During condensation, the master cone may have helped in pushing the material toward the difficult inaccessible areas of the resorption cavities. This is in accordance with some studies that have used GuttaFlow2 in normal canals without internal resorption and showed highest volume of obturation when compared to the vertical compaction thermoplasticized technique.[27] In another study, GuttaFlow2 was used with and without master cone in comparison with lateral compaction to evaluate apical microleakage, the GuttaFlow2 with master cone recorded the lowest mean of dye penetration, which was comparable to that of lateral compaction technique. From this result, the authors concluded that GuttaFlow2 with master cone was a good alternative to lateral compaction with sealer.[28] The current study is the first to use GuttaFlow2 to fill root canals with artificial internal resorption cavities and the medical literature lacks such investigation.

CONCLUSION

The GuttaFlow2 with a master cone technique seems to be a promising filling material and gave results similar to those observed with Obtura II. It is recommended to be used to obturate internal resorption cavities in clinical practice due to its good adaptability to root canal walls, ease of handling, and application.

REFERENCES

1. Patel S, Ford TP. Is the resorption external or internal? Dental Update 2007 May;34(4):218-220, 222, 224-226, 229.
2. Andreasen J. Review of root resorption systems and models, etiology of root resorption and the homeostatic mechanisms of the periodontal ligament. In: Davidovitch Z, editor. The biological methanisms of tooth eruption and root resorption. Birmingham: Ebesco Media;1988. p. 9-22.
3. Tronstad L. Root resorption—etiology, terminology and clinical manifestations. Dent Traumatol 1988 Dec;4(6):241-252.
4. Bell T. The anatomy, physiology and disease of the teeth. Philadelphia (PA): Carey & Lea; 1830.
5. Goultschin J, Nitzan D, Azaz B. Root resorption: review and discussion. Oral Surg Oral Med Oral Pathol 1982 Nov;54(5):586-590.
6. Çalişkan M, Türkün M. Prognosis of permanent teeth with internal resorption: a clinical review. Endod Dent Traumatol 1997 Apr;13(2):75-81.
7. Agarwal M, Rajkumar K, Lakshminarayanan L. Obturation of internal resorption cavities with 4 different techniques: an *in vitro* comparative study. Endodontology 2000;14:3-8.
8. Goldberg F, Massone E, Esmoris M, Alfie D. Comparison of different techniques for obturating experimental internal resorptive cavities. Dent Traumatol 2000 Jun;16(3):116-121.
9. Frank AL, Weine FS. Nonsurgical therapy for the perforative defect of internal resorption. J Am Dent Assoc 1973 Oct;87(4): 863-868.
10. Gutmann J, Saunders W, Saunders E, Nguyen L. An assessment of the plastic Thermafil obturation technique. Int Endod J 1993 May;26(3):173-178.
11. Collins J, Walker MP, Kulild J, Lee C. A comparison of three gutta-percha obturation techniques to replicate canal irregularities. J Endod 2006 Aug;32(8):762-765.
12. Budd CS, Weller RN, Kulild JC. A comparison of thermoplasticized injectable gutta-percha obturation techniques. J Endod 1991 Jun;17(6):260-264.
13. Özok AR, van der Sluis LW, Wu M-K, Wesselink PR. Sealing ability of a new polydimethylsiloxane-based root canal filling material. J Endod 2008 Feb;34(2):204-207.
14. Maziar F, Dianat O, Mahjour F. Comparing microleakage in root canals obturated with nanosilver coated gutta-percha to standard gutta-percha by two different methods. Iran Endod J 2011 Autumn;6(4):140-145.
15. Andreasen F, Sewerin I, Mandel U, Andreasen J. Radiographic assessment of simulated root resorption cavities. Dent Traumatol 1987 Feb;3(1):21-27.
16. ElAyouti A, Achleithner C, Löst C, Weiger R. Homogeneity and adaptation of a new gutta-percha paste to root canal walls. J Endod 2005 Sep;31(9):687-690.
17. Anantula K, Ganta AK. Evaluation and comparison of sealing ability of three different obturation techniques – lateral condensation, Obtura II, and GuttaFlow: an *in vitro* study. J Conserv Dent 2011 Jan;14(1):57-61.
18. Trope M, Chivian N. Root resorption. In: Cohen S, Burns R, editors. Pathways of the pulp. 6th ed. St. Louis (MO): CV Mosby; 1994; p. 486-530.
19. Andreasen JO, Andreasen FM, Andersson L. Textbook and color atlas of traumatic injuries to the teeth. John Wiley & Sons; 2013.

20. Gencoglu N, Yildirim T, Garip Y, Karagenc B, Yilmaz H. Effectiveness of different gutta-percha techniques when filling experimental internal resorptive cavities. Int Endod J 2008;41(10):836-842.
21. Stamos DE, Stamos DG. A new treatment modality for internal resorption. J Endod 1986 Jul;12(7):315-319.
22. Wilson P, Barnes I. Treatment of internal root resorption with thermoplasticized gutta-percha. A case report. Int Endod J 1987 Mar;20(2):94-97.
23. Langeland K. Root canal sealants and pastes. Dent Clin North Am 1974 Apr;18(2):309-327.
24. Peters DD. Two-year *in vitro* solubility evaluation of four gutta-percha sealer obturation techniques. J Endod 1986 Apr;12(4):139-145.
25. Kontakiotis EG, Tzanetakis GN, Loizides AL. A 12-months longitudinal *in vitro* leakage study on a new silicon-based root canal filling material (Gutta-Flow). Oral Surg Oral Med Oral Pathol Oral Radiol Endod 2007 Jun;103(6):854-859.
26. Ørstavik D, Nordahl I, Tibballs JE. Dimensional change following setting of root canal sealer materials. Dent Mater 2001 Nov;17(6):512-519.
27. Naseri M, Kangarlou A, Khavid A, Goodini M. Evaluation of the quality of four root canal obturation techniques using micro-computed tomography. Iran Endod J 2013 Summer;8(3):89-93.
28. Rana M, Sandhu GK, Kaur T, Arif M, Galyan G. New self curing root canal filling material: GuttaFlow 2. J Adv Med Dent Sci Res 2014 Oct-Dec;2(4):15-20.