

Original Research

A Comparative evaluation of different restorative materials as an alternative to crown coverage for endodontically treated mandibular molars- An in-vitro study

Apurva Sharma, Vishesh Gupta, B. Rajkumar, Akanksha Bhatt, Amit Nigam

Department of Conservative Dentistry and Endodontics, Babu Banarasi Das College of Dental Sciences, Lucknow, India

ABSTRACT:

Objectives- This study evaluated and compared the fracture resistance of different restorative materials as comparison to sound teeth. **Methods and Materials-** 75 extracted teeth were taken. Group A (n=15) was sound teeth followed by access opening, biomechanical preparation and obturation in other groups (Group B, C, D, E) followed by post endo-restoration with Ever X Posterior, Sonic Fill, Tetric N Ceram bulk fill and Beautifil flow were used. The fracture resistance was evaluated with the help of Instron machine. The fracture resistance of groups were compared by one factor analysis of variance and the significance of mean difference between the groups was done by Tukey's HSD post hoc test after ascertaining normality by Shapiro-Wilk's test and homogeneity of variance between groups by Levene's test. $P < 0.05$ was statistically significant. **Results-** Tukey's test showed significantly different and higher fracture resistance of Group A and Group B as comparison to other groups. **Conclusion-** Within the limitations of this study evaluated and compared to determine fracture resistance and comparison of Group A, B, C, D and E it can be concluded fiber reinforced (Ever X Posterior, Group B) composite could be considered as an alternative to crown coverage, considering the insignificant difference in the values of fracture resistance when compared to natural tooth.

Keywords- Fracture resistance, Ever X Posterior, Beautifil flow, Sonic fill and Tetric N Ceram bulk fill, Instron machine.

Received: 12 February, 2020

Accepted: 27 February, 2020

Corresponding author: Dr. Apurva Sharma, Department of Conservative Dentistry and Endodontics, Babu Banarasi Das College of Dental Sciences, Lucknow, India

This article may be cited as: Sharma A, Gupta V, Rajkumar B, Bhatt A, Nigam A. A Comparative evaluation of different restorative materials as an alternative to crown coverage for endodontically treated mandibular molars An in-vitro study. J Adv Med Dent Sci Res 2020;8(3):82-87.

INTRODUCTION:

In today's era, every patient opt to save his/her natural dentition rather than to go for extraction followed by its artificial replacement. To fulfill this, the treatment of choice is endodontic treatment of a pulpally infected tooth.

Endodontic treatment is carried out with various instruments in which Ni-Ti instruments were commonly used for biomechanical preparation. They have brought convenience and efficacy to root canal shaping and reduces procedural errors.^[3]

But it has been found that the endodontically treated teeth has higher potential to get fractured by masticatory forces than the vital teeth.^[1]

The prognosis of ETT depends not only on the endodontic treatment, but also on the restorative techniques.^[2]

The optimal method to restore teeth after its endodontic treatment continues to remain a controversial topic because tooth get more susceptible to biomechanical failure compared to vital teeth after endodontic treatment.^[2]

A root filled tooth is unlike a vital tooth due to the effect of endodontic treatment. It is thought that root canal treatment leads to ‘weakening’ of the remaining tooth structure. Although the effects are similar for both anterior and posterior teeth, the consequences are different due to the difference in tooth morphology and loading patterns.^[4] Mostly posterior teeth with extensive cavities require thick increments of composite which prevent polymerization.^[5] For endodontically treated teeth restoration various restoration modalities involves for better protection and reinforcement of the remaining tooth structure. Resin based composite has achieved a high degree of success in the restoration of decayed teeth.^[4] Fiber reinforcement of conventional composite enhance the physical and mechanical properties was due to stress transfer from the matrix.^[6] Fiber insertion with different method increase the fracture strenght of teeth restored with bulk fill composites, it increased the fracture modes.^[7] Along with this polyethylene fibers, nanohybrid composite and fiber reinforced composite could serve as an alternate to crown.^[14] A new resin based composite (RBC) material class, the bulk-fill RBCs, has been introduced in the past few years. They are attempted to speed up the restoration process by enabling up to 4 or 5-mm thick increments to be cured in one step, thus skipping the time-consuming layering process.^[8] Tetric N-Ceram Bulk Fill (Ivoclar, Vivadent) a recently introduced composite claims that it required an increment of minimum 2 mm when using the incremental technique and the composite will achieve full-depth bulk fill up to 4 mm without a superficial capping layer.^[9]

Lie et al found mean depth of cure of flowable composite ranged between 7.84 to 10.05 mm. Both studies found the depth of cure for flowable composite higher than that for conventional.^[10]

Flowable resin-based composites are conventional composites with the filler loading reduced to 37%-53% (volume) compared to 50%-70% (volume) for conventional mini-filled hybrids. This altered filler loading modifies the viscosity of these materials.^[11]

Resin composite restorations had higher fracture strength than other restorations.^[12]

The bulk-fill composite resin showed less shrinkage, polymerization stress, cusp deflection and micro-hardness than conventional composite.^[13]

A Direct composite is often preferred over full crowns because ease of manipulation, less time consuming and cost effectiveness.

The fracture resistance is the property of a material when this is resisting the development of a fracture.

In current study fracture resistance test of composites were carried out with the help of Universal Testing machine (Instron)

MATERIAL AND METHODS- 75 intact human mandibular molars, extracted for periodontal reasons were collected. All the specimens were scaled to remove the adhering soft tissue and calculus and stored in saline. Teeth with caries, fracture were discarded. 15 intact teeth were used as control group A and endodontic access cavities were prepared in 60 teeth using airotor hand piece and endo access bur. The dimension of access cavity were decided with the help of a periodontal probe to standardize the remaining tooth structure. The remaining thickness was 1.5 mm through out the circumference of the tooth.^[11]

A size 10 and 15 K-file was introduced into each canal until it could be seen at the apical foramen. The working length was then determined by subtracting 1mm from this length.

The canals were ProTaper Universal Ni-Ti rotary system is machined from conventional super-elastic austenite Ni-Ti wire. It has variable taper over the entire blade length with convex triangular cross sections.^[15]

It has shaping (S1 size 17, 0.2 taper) and S2 (size 20, 0.4 taper) and finishing F1 (size 20, 0.7 taper), F2 (size 25, 0.8 taper), F3 (size 30, 0.9 taper) files.^[16]

Copious irrigation using 5 ml of 5.25% sodium hypochlorite was carried out throughout the procedure.

The root canals were flushed with saline to remove traces of sodium hypochlorite. The canals were then dried with absorbent paper points (Dentsply Maillefer). Obturation was done with ProTaper F2 gutta percha points and AH Plus root canal sealer (Dentsply De Trey, Konstanz, Germany) using a cold lateral condensation technique.^[11]

Subsequently, the teeth were randomly divided into three groups (n=15):

Group A- Obturated teeth restored with Ever X Posterior.

Group B- Obturated teeth restored with Tetric N Ceram Bulkfill

Group C- Obturated teeth restored with Beautifill flow

Group D- Obturated teeth restored with Sonicfill



Preparation of specimens

Group A- Sound teeth 15 (with no access cavity preparation and restoration)

Group B – In 15 Endodontically treated teeth 37.5% phosphoric acid (Gel Etchant, Kerr Italia Srl, Scafati, Italy) was applied for 10 seconds and then rinsed for 15seconds excessive water was removed using cotton pellet without dehydrating the dentin by air application of Opti-bond FL adhesive was done and light cured for 10 s using Elipar S 10 at 1200 mW/ cm². After this procedure Ever X posterior was inserted into the cavity in a buccal to lingual direction and was polymerized for 40 seconds.^[17]

Group C- Endodontically treated teeth were acid etched for 10 seconds and rinsed for 15 seconds Beauti-bond was then applied and cured for 30 seconds followed by application of Beautifil flow composite with curing time for 10 seconds.

Group D- Endodontically treated teeth were acid etched as in group C followed by Opti Bond application curing for 20 second. The teeth were then restored with Tetric N Ceram bulk fill followed by light curing for 20 seconds.

The primer (Opti bond) was actively applied in the cavity, followed by air-drying for five seconds. The adhesive (Opti-bond FL, 2 Adhesive, Kerr Italia Srl) was then actively applied air-dried for three seconds and light-activated for 20 seconds (950±50 m W/cm², blue phase, IvoclarVivadent). 4-mm increment of the designated bulk-fill resin composite was inserted into the cavity and then light-activated for 20 seconds.^[18]

Group E- In endodontically treated teeth the etchant application was done same as in group C followed by adhesive application and curing for 10 seconds. Teeth were then restored by placing Sonic fill in bulk increments upto 5 mm followed by shaping the occlusal surface and light curing for 20 seconds. After Post endo restoration, each tooth was finished with diamond finishing bur. Each tooth was then coated with a layer of polyvinyl siloxane impression material of the tooth perpendicular to the base of block and the remaining structure was embedded in a block of self-cure acrylic resin with the long axis.

The Endodontically treated teeth in Group A,B,C,D, E were stored for 24 hour after finishing the restoration and thereafter they were subjected to fracture resistance test. One by one all the mounted specimen were placed onto the universal testing machine with cross head speed of 1mm per minute until failure.^[19]The observation were tabulated and statistically analysed further.



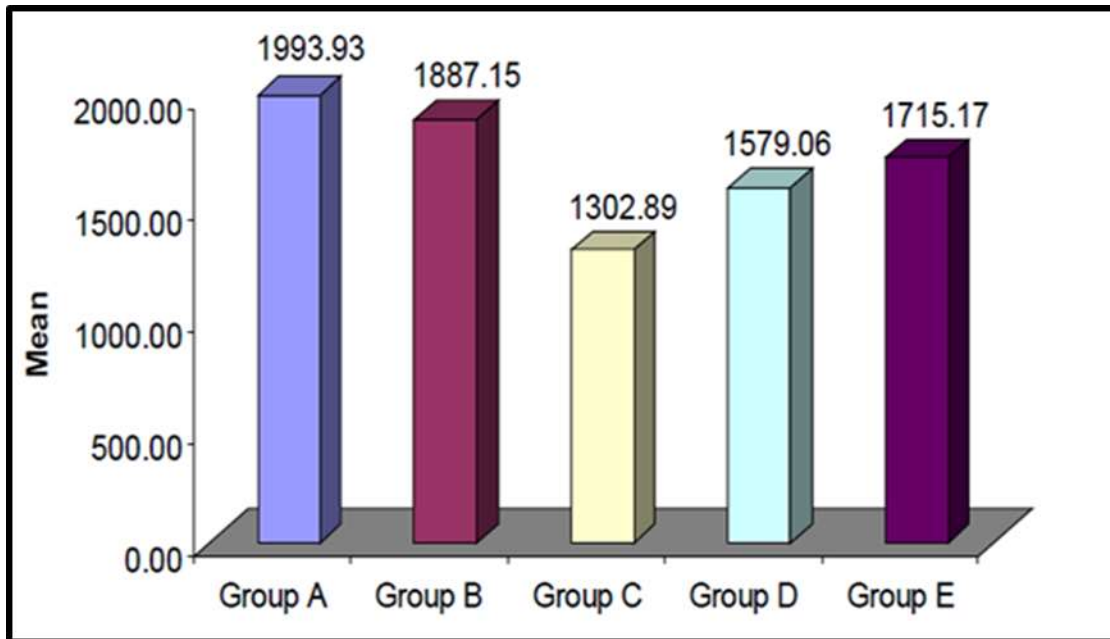
Data were summarised as Mean ± SE (standard error of the mean). Five independent groups were compared together by one factor analysis of variance (ANOVA) and the significance of mean difference between (inter) the groups was done by Tukey's HSD (honestly significant difference) post hoc test after ascertaining normality by Shapiro-Wilk's test and homogeneity of variance between groups by Levene's test. A two-tailed ($\alpha=2$) $P<0.05$ was considered statistically significant. Analyses were performed on SPSS software (Windows version 17.0).

RESULTS:

The fracture resistance (N) of five groups is summarised in Table 1 and also depicted in Group 1. The mean fracture resistance of Group A, Group B, Group C, Group D and Group E ranged from 1082.80-2616.40, 614.90-2653.10, 678.30-2175.40, 418.50-2306.60 and 106.40-2238.90 N respectively with mean (\pm SE) 1993.93 \pm 112.58, 1887.15 \pm 144.61, 1302.89 \pm 114.29, 1579.06 \pm 109.02 and 1715.17 \pm 141.07 N respectively the median observation was 2022, 1920, 1396, 1580 and 1905 N, respectively. The median fracture resistance of Group A until fracture was the highest followed by Group B, Group E, Group D and Group C (the least) (Group C < Group D < Group E < Group B < Group A) (Table 1 and Graph 1).

TABLE 1: FRACTURE RESISTANCE (N) OF FIVE GROUPS

Group	N	Mean ± SE	F value	P value
Group A	15	1993.93 ± 112.58	4.68	0.002
Group B	15	1887.15 ± 144.61		
Group C	15	1302.89 ± 114.29		
Group D	15	1579.06 ± 109.02		
Group E	15	1715.17 ± 141.07		



GRAPH 1: MEAN FRACTURE RESISTANCE OF FIVE GROUPS.

DISCUSSION

In this study, sample size of seventy five extracted human permanent mandibular molar teeth were chosen as this sample size was found statistically significant. Inside the oral cavity, the posteriors are subjected to greater masticatory and are more prone to fracture than anterior teeth so they were taken in study.^[19]

The aim of the present study was to evaluate fracture resistance of the recent restorative materials that can be used as an alternative to crown on endodontically treated teeth (ETT). The fracture resistance of ETT is of prime importance as it has been found that a root canal treated tooth requires 2.5 times more load than a vital tooth.^[4]

It has been evaluated that the loss of one marginal ridge resulted in a 46% loss in tooth strenght.^[20] However, this factor was controlled in the present study by maintaining 1.5 mm remaining marginal ridges width in all endodontic access cavity prepared samples.

Warattama Suksaphar et.al which showed that fracture resistance of ETT restored with resin composite restoration was similar to that of sound tooth.^[21]

Mechanical properties of various composite resin materials is influenced by monomer system, filler type, filler loading and filler-resin interphase.^[22]

Bulk-fill materials allow increment thickness up to 4-5 mm, thus decreasing the lengthy operating time as compared to conventional composites.^[23]

The following restorative composite resins were chosen for the present study: Ever X posterior (Group B), Beautifil flow (Group C), Tetric N Ceram Bulk fill (Group D) and Sonic Fill (Group E). Group A was taken as Control group where the samples were devoid from endodontic access cavity preparation or restoration.

Short fiber reinforced composite (SFRC) like Ever X Posterior offers an efficient solution to restore the pulpal cavity in a root canal treated tooth. The lower polymerization shrinkage of SFRC compared to particulate filler composite causes less shrinkage stress in the interface between the filling and tooth tissue.^[10]

Beautifil flow provides the fluoride release and recharge property of glass ionomer along with the superior esthetics, physical properties and handling property of composite resin.^[24]

Tetric N Ceram Bulk fill composite will achieve full depth fill up to 4mm without a superficial capping layer.

Recently introduced Sonic Fill restorative system by Kerr provides sonic application of a bulk-fill type composite. It has a high (84%) filler content which enhances its mechanical properties.^[26]

Standardized endodontic access opening were prepared into the selected mandibular molars samples. The canals were negotiated, cleaned and shaped with Pro Taper Universal rotary file system till F2 size. After complete biomechanical preparation canals were dried with ProTaper paper points and obturated with Gutta percha and the experimental teeth were restored with respective experimental allocated materials. The samples were then subjected to Universal testing machine to evaluate fracture resistance. Load was applied to samples to simulate occlusal loads and assess the fracture resistance under load application.^[27] The observations were laid down tabulated and statistically analyzed.

Tronstad et.al. has also stated that a good restoration especially in root canal filled teeth is an important step for the longtime success of such treated teeth.^[28] To withstand the masticatory forces, the post endodontic restorative material should have high flexural strength similar to that of tooth structure.^[29]

The results of the present study revealed that the fracture resistance was seen highest in Group B (Ever X Posterior) experimental group followed by Group E (Sonic fill), Group D (Tetric N Ceram bulk fill) and least in Group C (Beauti fill flow) experimental group.

In the present study, the fracture resistance shown by the Ever X Posterior (Group B) was found highest because it contains polyethylene fibres (E –Glass fibers) that create polyethylene network that further provides a modification in the stress dynamics at the restoration-adhesive resin interface.

The present study finding is supported by the results obtained study done by FluryS et. al., Galvao MR et.al and Polydorou O et. al and Yap A U et.al.^[31-34]

In the present study, Group B (Ever X Posterior) showed statistical values were very close to the control group A. The results obtained in the present study were in accordance to the results obtained from the study done by Hemalatha Hiremath et.al.^[14]

Sonic Fill restorative material with highest filler content (80%) showed high fracture resistance.

In the present study, Group D (Tetric N Ceram Bulk fill) showed better fracture resistance than Beautifil flow (Group C) due to use of pre-polymer shrinkage stress relieving technology and incorporation of Ivocerin photo-initiator^[30] and photosensitive fillers which permitted its use in 4mm thick increments without compromising its physical properties.^[27]

In the present study, lowest fracture resistance was found in Beautifil flow (Group C). The reason attributed for this lowest fracture resistance is its flowability which inturn is due to reduced filler loading (67.3 wt% or 47.0 vol%) thus affecting the overall fracture strength. This result is in accordance with the results obtained from study done by UM Abdel-Karim et.al.^[35]

CONCLUSION

Within the limitations of this in vitro study, titled “A Comparative evaluation of different restorative materials as an alternative to crown coverage for endodontically treated mandibular molars: An in-vitro study” evaluated and compared to determine the fracture resistance and comparison of Ever X posterior, Beautifil flow, Sonic fill and Tetric N Ceram bulk fill it can be concluded that fiber reinforced composite could be considered as an alternate to crown coverage, considering the insignificant difference in the values of fracture resistance when compared to that of natural tooth.

REFERENCES:

1. Kim EH, Jung KH, Son SA, Hur B, Kwon YH, Park JK Effect of resin thickness on the micro hardness and optical properties of bulk-fill resin composites. *Restor Dent Endod.* 2015 May; 40(2):128-35. Epub 2015 Jan 13.
2. Carvalho MA, Lazari PC, Gresnigt M, Cury ADB, Magne P. Current options concerning the endodontically treated teeth restoration with the adhesive approach *Braz. Oral Res* 2018; 32 (suppl): e 74
3. Necchi S, Taschieri S, Petrini L, Migliavacca F Mechanical behaviour of nickel-titanium rotary endodontic instruments in simulated clinical conditions: A computational study *International Endodontic Journal* 41(11):939-49 • December 2008
4. Eliyas S, Jalili J, Martin N Restoration of the root canal treated tooth. *Br Dent J.* 2015 Jan; 218(2):53-62
5. Jaber ZA, Ghasemi A, Taghi MV, Motamedi MK Effect of Curing Time on Polymerization Rate of Bulk-Fill Composite Resins *J Dent Sch GYear* 34(4) : 214-224
6. Luthria A, Sreerika A, Hegde J, Karale R The reinforcement effect of polyethylene fibre and composite impregnated glass fibre on fracture resistance of endodontically treated teeth: An in vitro study *Journal of Conservative Dentistry* 15(4):372-6 October 2012
7. Kim ME, Park SH. Comparison of premolar cuspal deflection in bulk or in incremental composite restoration methods *Oper Dent.* 2011 May-Jun; 36(3):326-34. Epub 2011 Aug 9
8. Ilie N, Bucuta S, Draenert M (2013) Bulk-fill Resin-based Composites: An In Vitro Assessment of Their Mechanical Performance. *Operative Dentistry*: November/December 2013, Vol. 38, No. 6, pp. 618-62
9. Chesterman J, Jowett A, Gallacher A, Nixon P *Br Dent* Bulk-fill resin-based composite restorative materials: a review. *J.* 2017 Mar 10; 222(5):337-344. 2017.214.

10. Nujud S.A. Edrees, Hadeel S. A. Amer, Khalid M. Abdelaziz, Wafa Alajam, Benefits and Drawbacks of Bulk-fill dental composites: a systematic review *European Journal of Pharmaceutical and Medical research Ejpnr*, 2017,4(10), 124-137
11. Baroudi, Kusai, and Jean C Rodrigues. "Flowable Resin Composites: A Systematic Review and Clinical Considerations." *JCDR* vol. 9, 6 (2015): ZE18-24.
12. Taha NA, Palamara JE, Messer HH. Fracture strength and fracture patterns of root-filled teeth restored with direct resin composite restorations under static and fatigue loading. *Oper Dent*. 2014 Mar-Apr; 39(2):181-8. Epub 2013 Jul 12
13. Felipe L, Schneider J, Cavalcante LM & Silikas N Volume Shrinkage Stresses Generated during Resin-Composite Applications: A Review 2010, 14 pages
14. Hiremath H, Kulkarni S, Hiremath V, Kotipalli M Evaluation of different fibers and biodentine as alternates to crown coverage for endodontically treated molars: An in vitro study Year: 2017 Volume : 20, Issue : 2, Page : 72-75
15. Nishad SV, Shivamurthy GB Comparative analysis of apical root crack propagation after root canal preparation at different instrumentation lengths using protaper universal, protaper next and protaper gold rotary files: An in vitro study
16. Alqedairi A, Alfawaz H, Abualjadayel B, Alanazi M, Alkhalifah A, Jamleh Torsional resistance of three Pro-Taper rotary systems *BMC Oral Health* December 2019, 19: 124
17. Shinkai K, Taira Y, Suzuki S, Kawashima S, Suzuki M Effect of filler size and filler loading on wear of experimental flowable resin composites *J Appl Oral Sci* v26; 2018
18. Bhandary N, Desai A, Shetty YB High speed handpieces *J Of International Oral Health* 2014; 6(1): 130-132
19. Shinkai K, Taira Y, Suzuki S, Kawashima S, Suzuki M Effect of filler size and filler loading on wear of experimental flowable resin composites *J Appl Oral Sci* v26; 2018
20. Neslihan T, Kansad P, Safa T, Mustafa D, Merve S Influence of polymerization method and type of fibre on fracture strength of endodontically treated teeth. *Aust Endod* 2017; 43: 115-122
21. Suksaphar W, Banomyong D, Jirathyanatt T, Ngoenwiwatkul Y Survival rates against fracture of endodontically treated posterior teeth restored with full-coverage crowns or resin composite restorations: a systematic review *Restor Dent Endod*. 2017 Aug; 42(3):157-16.
22. Reeh ES, Messer HH, Douglas WH Reduction in tooth stiffness as a result of endodontic and restorative procedures. *J Endod*. 1989 Nov; 15(11):512-16.
23. Mohammad DA, Al-Johany S, Sherfudhin H, Shammari BA, Mohefer SA, Saloum M Fracture resistance of endodontically treated mandibular first molars with conservative access cavity and different restorative techniques: An invitro study. *Aust Endod J* 2016; 42:124-131
24. Baroudi K and Rodrigues JC. Flowable Resin Composites: A Systematic Review and Clinical Considerations *J ClinDiagn Res*. 2015 Jun; 9(6): ZE18-ZE24.
25. Sunbul HA, Silikas N, Watts DC. Surface and bulk properties of dental resin-composites after solvent storage. *Dent Mater* 2016; 32:987
26. Jyothi KN, Annapurna S, Kumar AS, Venugopal P, Jayashankara CM Clinical evaluation of giomer and resin-modified glass ionomer cement in class V non-carious cervical lesions: an in vivo study *J Conserv Dent*, 14 (2011), pp. 409-413
27. Niloofer KR, Bahar J, Panahandeh N, Ghasemi A, Kamali A, Gholamhasan M. Microleakage of Bulk-Fill composite at two different time points. *Journal of Dental School* 2016; 34(4): 225-34
28. Safi L, Forouzanfar M, Alizadeh F. An in vitro evaluation of fracture resistance of endodontically treated teeth with different restorative materials *J. Contemp Dent Pract* 2016; 17:549-52
29. Tronstad L, Asbjornsen K, Doving L, Pedersen I, Eriksen HM. Influence of coronal restorations on the periapical health of endodontically treated teeth. *Endod Dent Traumatol* 2000; 16:218-21
30. Combe EC, Shaglouf AM, Watts DC, Wilson NH. Mechanical properties of direct core build-up materials. *Dent Mater* 1999; 15:158-65
31. Dionysopoulos D, Tolidis K, Gerasimou P *Materials Research* 2016; 19(2): 466-473 The Effect of Composition, Temperature and Post Irradiation Curing of Bulk Fill Resin composites on Polymerisation Efficiency.
32. Flury S, Hayoz S, Peutzfeldt A, Hüsler J, Lussi A. Depth of cure of resin composites: is the ISO 4049 method suitable for bulk fill materials? *Dent Mater* 2012; 28: 521-528.
33. Galvao MR, Caldas SG, Bagnato VS, de Souza Rastelli AN, de Andrade MF Evaluation of degree of conversion and hardness of dental composites photo-activated with different light guide tips. *Eur J Dent* 2013; 7: 86-93.
34. Tanner J, Tolvanen M, Garoushi S, Sailyoja E. Clinical Evaluation of Fiber-Reinforced Composite Restorations in Posterior Teeth - Results of 2.5 Year Follow-up. *Open Dent J*. 2018; 12:476-485.