Type of Manuscript : *Original Research*

Association between Tooth and Type of Instrument Fractured During Root Canal Treatment

Krisha Doshi[1], S.Delphine Priscilla Antony[2]

Research Associate, Dental Research Cell , Department of Conservative Dentistry and Endodontics, [2]Senior lecturer, Department of Conservative Dentistry and Endodontics Saveetha Dental College, Saveetha Institute of Medical and Technical Sciences,, Saveetha University, Chennai

Abstract

Instrument fracture is a common unfortunate event that takes place during the root canal treatment. A good knowledge about the different instruments that can fracture, causes of fracture, predilection of teeth towards fracture of instruments, etc will help the clinician to be more alert. It will also help clinicians gain confidence towards methods of retrieval of these instruments. The aim of this study was to analyse the association between the tooth and the type of instrument separated during root canal treatment. The study was based on an online setting. Data was collected retrospectively. Patient reports of 86000 patients that reported to the institution between June 2019 and March 2020 were reviewed. Data of instrument retrievals done from December 2019 to March 2020 was collected. Excel sheet tabulations were made involving tooth number, type of instrument fractured and method of retrieval. Descriptive statistics was done on SPSS software. Association between the tooth and type of instrument was analyzed with Chi Square test. No statistical significant difference was seen between the tooth and type of instrument fractured. ($p>0.05$). The tooth type does not influence the type of instrument fractured significantly.

Keywords: *Instrument separation ; instrument fracture ; tooth type ; instrument retrieval ;retrieval technique ; root canal treatment.*

Introduction

Root canal preparation is a procedure in endodontics during which microbial pathogens present in the root canal system are eliminated. It is probably the most important stage of non surgical endodontic treatment. Because canal disinfection is achieved by mechanical debridement and use of irrigants and medicaments, enlargement of the root canal space is essential to facilitate the flow of the irrigating agent[1] as well as for the placement of filling material later on. Today, the concept of cleaning and shaping is drifting towards use of irrigants for cleaning and disinfecting canals more than mechanical shaping of the canals[2]. Endodontic instruments for cleaning and shaping have come a long way since their first invention. With the developing technology various inventions have been made even in this field, beginning with innovative designs for diagnostic instruments like pulp vitality testers[3], constantly changing the designs of these instruments. The trend is slowly changing from using various sizes of stainless steel files to using NiTi files[4], to using a single file for the entire preparation[5]. There have been suggestions for non instrumentation techniques to clean and obturate the root canal[6,7], however this technique is still experimental. There have been various advances even in materials and techniques used for irrigation and intracanal medication, with new materials being introduced into the market constantly.

Corresponding author:
S. Delphine Priscilla Antony
Senior lecturer, Department of Conservative Dentistry and Endodontics, Saveetha Dental College,
Saveetha Institute of Medical and Technical Sciences,
Saveetha University, 162, Poonamallee High Road,
Chennai- 600077,
Email id- delphine.sdc@saveetha.com
Mobile No - +91 9790856274

A well informed choice must be made as to which material to use in different clinical scenarios. A survey was done to evaluate the use of intracanal medications by dental practitioners[8]. The detailed mechanism of action, interactions, toxicity, etc of each material must be analyzed before using it clinically[9]. Interaction of different irrigants may lead to formation of precipitates which may cause toxic and carcinogenic effects on tissues [10]. Infact, research today is oriented towards nipping the problem at the bud. Remineralizing pastes, mouth rinses, etc are being introduced that prevent dental caries and cavitation thus reducing the need for endodontic treatment [11,12]. New restorative materials, involving resin composites with exceptional properties are being manufactured to improve the long term success of restorations [13]. Advances in laminates and veneering techniques and materials have made it possible to treat discoloured vital teeth more conservatively without the need for intentional endodontic treatment [14].

In spite of technology being so advanced, improving the efficiency of cleaning and shaping instruments, instrument fracture or separation is a common and unfortunate mishap that takes place. No material is infallible, hence an instrument will fracture if its ultimate strength is exceeded. The most commonly fractured instruments are files, reamers, broaches, peeso reamers, GG drills, paste fillers, spreaders, etc. Stainless steel files or reamers are typically operated manually, and fracture is often a result of overuse and is associated with pre-existing distortion of the instrument which acts as warning sign [15]. On the other hand, rotary files may fracture without any warning signs. Incidence rates of intracanal instrument fracture have been reported between 0.25% and 6% for hand instruments while it is seven times higher for rotary instruments [16]. Reasons for instrument fractures apart from manufacturer related factors are flexural fatigue or torsional loading [17,18].

Incase of an experienced clinician, fracture of an instrument does not adversely affect the outcome of an endodontic treatment. Successful treatment depends on proper debridement and disinfection of the root canal system and preventing reinfection by placing a good quality coronal restoration [19]. The tooth and type of instrument fractured also play an important role in the treatment outcome.

It is well documented that tooth influences the probability of instrument fracture, but there is no evidence that there is an association between the tooth and the type of instrument fractured. This knowledge will alert the clinician in case he encounters such situations. Hence this study aims at analyzing the association between the tooth and type of instrument fractured. It further analyzes the association between the instrument fractured and the method used for its retrieval.

Materials and Methods

DATA COLLECTION AND ANALYSIS

This study was conducted in an institutional online setting. One researcher and one guide were involved. Approval was obtained from the institutional review board. Data was collected retrospectively. Patient records of 86000 patients that reported to the institution from June 2019 to March 2020 were reviewed. Data of all instruments separated and retrieved from December 2019 to March 2020 was collected. Excel sheet tabulations were constructed for tooth number, instrument type and technique of retrieval. Data was imported into SPSS software (Version 23.0).

Statistical Analysis

Descriptive statistics was done to evaluate the frequency and distribution of instrument separation in the institution. Chi square test was used to determine the association between tooth and instrument type as well as instrument type and technique of retrieval.

Results and Discussion

A total of 18 instrument separations and retrievals took place in the institution from December 2019 to March 2020. Maximum number of instruments separated in maxillary anteriors (33.3%), followed by maxillary molars and mandibular anteriors (22.2% each), followed by mandibular molars (16.7%) and least by maxillary premolars (5.6%) [Figure 1].

50% of the instruments fractured were rotary NiTi files; 22.2% were H files; 11.1%were K files and 16.7% were others (including reamers, broaches, etc) [Figure 2].

The most common technique of retrieval of separated instruments in this study was by ultrasonics

(44.4%), followed by mechanical technique(33.3%), and least by manual technique (22.2%) [Figure 3].

There was no significant association seen between the tooth and type of instrument fractured ($p<0.05$). All K files fractured in maxillary anteriors. Most rotary files fractured in mandibular anteriors and all molars. [Figure 4].

There was no significant association observed between the type of instrument fractured and technique of retrieval ($p<0.05$). All H files were retrieved ultrasonically. Most rotary files were retrieved with ultrasonics or mechanically [Figure 5].

The intracanal breakage of root canal instruments causes endodontists considerable anxiety [20]. This is because this unfortunate event is associated with many complications ranging from post operative pain to large periapical inflammation, infections and swelling. Inflammatory markers can be used to assess the periapical inflammation present. Recently, MMP-3 gene expression was shown to have higher levels in inflammatory conditions [21]. Post operative pain may also arise due to various other factors including method of instrumentation used, irrigants, irrigation techniques[22], obturation techniques, sealer used, etc. In case of retaining the fractured fragment, the treatment outcome is not always predictable even after sufficient disinfection of root canals. Hence the best outcome is achieved on removal of the separated fragment [23].

In this study, a total of 18 instruments were separated from which 33.3% were separated in maxillary anteriors, 22.2% in maxillary molars and mandibular anteriors, 16.7% in mandibular molars and 5.6% in maxillary premolars. This is in contradiction to the previous studies which stated that molars have higher incidence of instrument separation [24,25]. In a study done by Ungerechts et al, a higher frequency of instrument fracture was found in molars (1.8%) compared with premolars (0.7%) and incisors (0.3%) [24]. A higher incidence in these teeth may be due to the fact that molars usually show the presence of curved canals or calcifications. This may be a predisposing factor for excess fatigue on the instrument causing it to fracture. Various techniques have been described in literature to negotiate calcified canals that may help reduce the incidence of instrument separation [26]. The reason for a contradictory finding in our study could be the small sample size which has skewed the data towards anteriors. Maxillary and mandibular anteriors are most prone to dental trauma which may require endodontic treatment. Even severely traumatized teeth including avulsion can be saved by reimplantation if extraoral dry time is minimal. For this, various storage media are recommended [27]. In cases of mild trauma involving Ellis Class 1 and 2 fractures, endodontic treatment may not be necessary. A survey was done to assess the modalities of treatment for such teeth by dental practitioners [28].

When the type of instrument fractured was analyzed, 50% of the fractures occurred in rotary instruments while the other half was stainless steel. Out of these, 11.1% were K files, 22.2% were H files and 16.7% were others including reamers, broaches, etc. This is in accordance with a study by Iqbal et al in 2002, which stated that 85% of files fractured were NiTi rotary files while 15% were stainless steel [16]. It is in contradiction with a study by Ungerechts et al which stated that most of the fractured instruments were K reamers, K files, K flex (71%) and NiTi instruments (18.4%) [24]. This may be due to the fact that almost 70% of the RCTs done in the institution are done by postgraduates who use rotary files and hence the recorded instrument separation is more for rotary files.

Ultrasonics were used for instrument retrieval 44.4% of the time. 33.3% used mechanical technique while 22.2% used manual technique. This is in accordance with an article by Nagai et al and Nimet et al which stated that ultrasonics are one of the best techniques of instrument retrieval endodontics. [29,30] The reason for this may be that most post-graduate students trained for instrument retrieval have easy access to ultrasonics and endodontic microscopes in the institution. The manual technique involves the use of hand files (H- files), spoon excavators or various gripping devices like fine hemostats, pin pliers or Stiglitz forceps. Except for H-files that may be inserted into the root canals, all of the others are applicable only for fragments that extend into the pulp chamber[31]. Mechanical techniques include the use of extraction tubes, Messaran technique, canal finder system, etc.

No significant association was observed between the tooth and the type of instrument fractured. Previous studies have shown that cyclic fatigue increases with

increase in curvature of canals. This increases the tendency of rotary files to fracture in curved canals such as mesial canals of lower molars, disto buccal canals of upper molars, premolars, etc. [32]

No significant association was observed between the type of instrument fractured and method of retrieval, although a slight predilection of using ultrasonics for retrieval of stainless steel files was observed.

The limitation of this study is that it is restricted to a single small population in a confined geographical area. The sample size is too small to make any strong conclusions. The data was retrospectively collected in a small time frame of four months. This may have increased the bias of the study. Hence more long term research needs to be done in this subject on a larger population for the conclusions to be generalized.

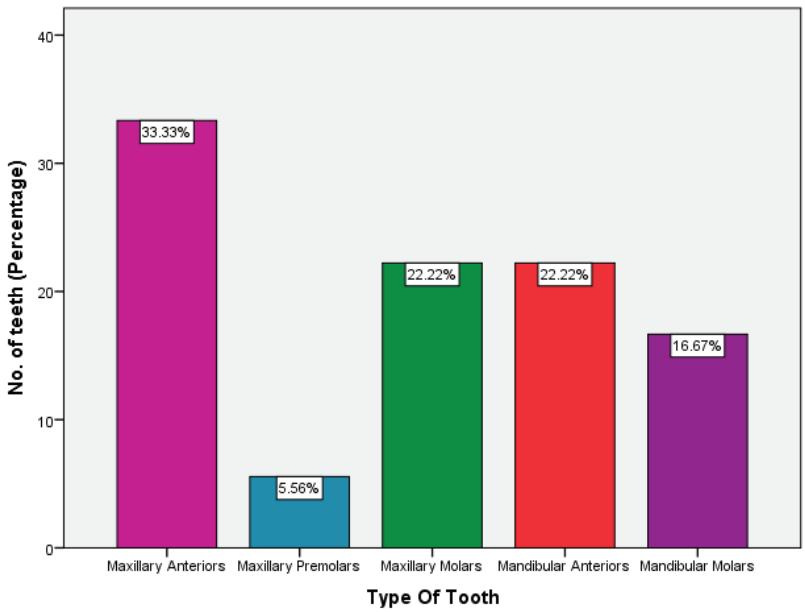

Figure 1: Bar graph representing the percentage distribution of teeth in which instrument separation had occurred. Pink bar represents maxillary anteriors, blue bar represents maxillary premolars, green bar represents maxillary molars, red bar represents mandibular anteriors and purple bar represents mandibular molars. Maximum separation occurred in maxillary anterior teeth (33.3%), followed by maxillary molars and mandibular anteriors (22.22% each), mandibular molars (16.7%) and maxillary premolars (5.6%).

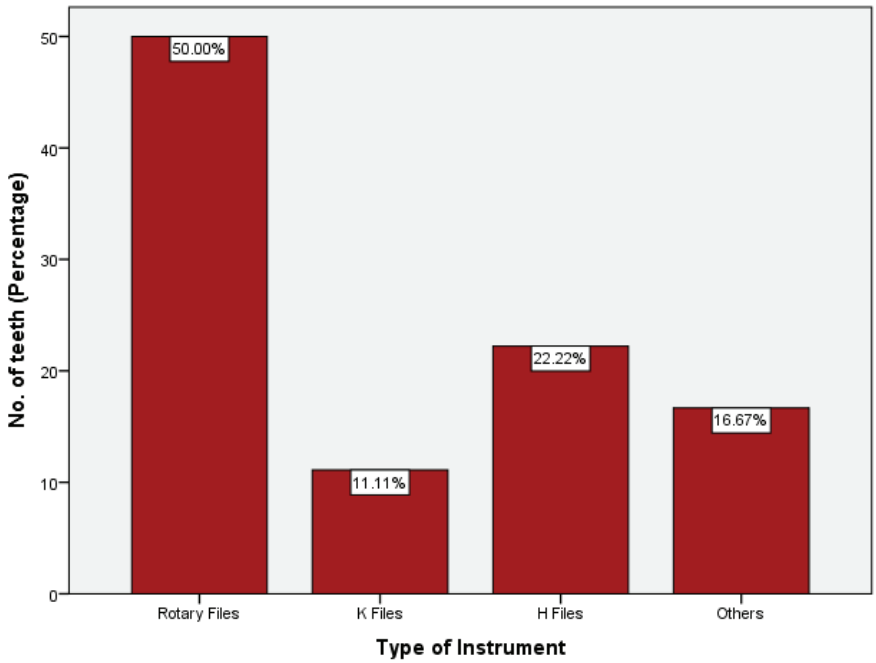

Figure 2: Bar graph representing the percentage distribution of type of instrument separated and retrieved. Maximum separations of rotary files were seen (50%), followed by H files (22.22%). 11.11% separations were of K files and 16.67% were other instruments including reamers, broaches, etc.

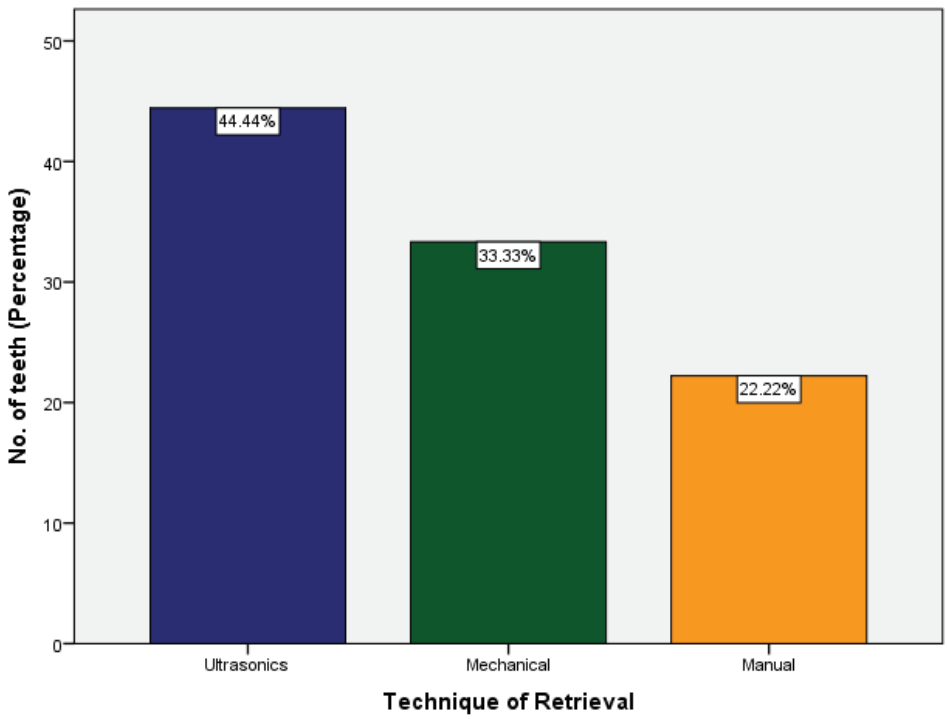

Figure 3: Bar graph representing the percentage distribution of techniques used for retrieval of separated instruments. Blue bar represents ultrasonics, green bar represents mechanical techniques and orange bar represents manual techniques. Maximum instrument retrievals were done by ultrasonics (44.4%), followed by mechanical techniques (33.3%) and manual technique (22.2%).

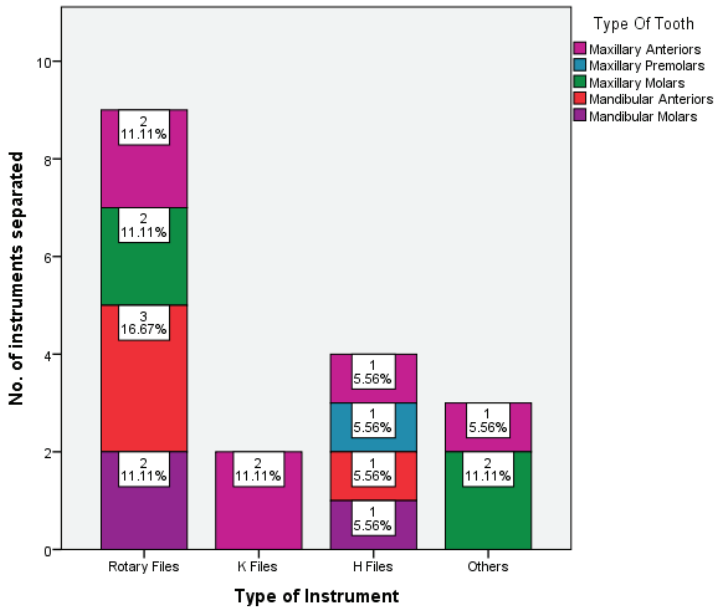

Figure 4: Bar graph representing association between tooth and type of instrument separated. Type of instrument separated was represented on the X axis and the number of instruments separated in each tooth was represented on the Y axis. Pink bar represents maxillary anteriors, blue bar represents maxillary premolars, green bar represents maxillary molars, red bar represents mandibular anteriors and purple bar represents mandibular molars. Association was statistically insignificant (p=0.342), although maximum rotary file separated in mandibular anteriors and all K files fractured in Maxillary anteriors. Chi square test was used to analyze the association.

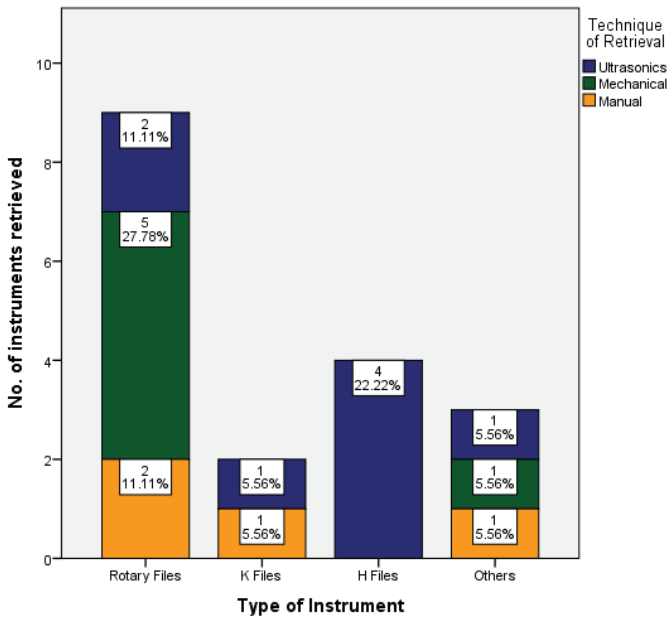

Figure 5: Bar graph representing the association between type of instrument separated and technique of retrieval. Type of instrument was represented on the X axis and the number of instruments retrieved for each technique of retrieval was represented on Y axis. Blue bar represents ultrasonics, green bar represents mechanical techniques and orange bar represents manual techniques. Association was statistically insignificant (p=0.176), although H files were retrieved by ultrasonics and the mechanical techniques were used more commonly for retrieval of rotary files. Chi square test was used to analyze the association.

Conclusion

Within the limitations of this study no significant association was observed between the tooth and type of instrument separated during the root canal treatment. Additionally, no significant association was observed between the instrument fractured and the method of retrieval.

Acknowledgement: The authors would like to acknowledge all the faculty of the Department of Conservative Dentistry and Endodontics, Saveetha Dental College, Chennai for their help with data collection for this study.

Conflict of Interest: The authors deny any conflicts of interest related to this study.

Source of Funding: Self.

Ethical Clearance: It is taken from "Saveetha Institute Human Ethical Committee" (Ethical Approval Number- SDC/SIHEC/2020/DIASDATA/0619-0320)

References

1. Gulabivala K, Stock CJR, Gulabivala K, Walker RT. Root canal system preparation. In: Endodontics. Elsevier, Mosby, Edinburgh; New York; 2004. p. 142–4.
2. Teja KV, Ramesh S. Shape optimal and clean more. Saudi Endodontic Journal. 2019 Sep 1;9(3):235.
3. Janani K, Palanivelu A, Sandhya R. Diagnostic accuracy of dental pulse oximeter with customized sensor holder, thermal test and electric pulp test for the evaluation of pulp vitality - An in vivo study [Internet]. Vol. 23, Brazilian Dental Science. 2020. Available from: http://dx.doi.org/10.14295/bds.2020.v23i1.1805
4. Ramanathan S, Solete P. Cone-beam Computed Tomography Evaluation of Root Canal Preparation using Various Rotary Instruments: An in vitro Study. J Contemp Dent Pract. 2015 Nov 1;16(11):869–72.
5. Shay B, Moshonov J. Single file endodontic treatment: a new era? Refuat Hapeh Vehashinayim [Internet]. 2013; Available from: https://europepmc.org/abstract/med/24020240
6. Lussi A, Portmann P, Nussbächer U, Imwinkelried S, Grosrey J. Comparison of two devices for root canal cleansing by the noninstrumentation technology [Internet]. Vol. 25, Journal of Endodontics. 1999. p. 9–13. Available from: http://dx.doi.org/10.1016/s0099-2399(99)80390-2
7. Lussi A, Suter B, Fritzsche A, Gygax M, Portmann P. In vivo performance of the new non-instrumentation technology (NIT) for root canal obturation [Internet]. Vol. 35, International Endodontic Journal. 2002. p. 352–8. Available from: http://dx.doi.org/10.1046/j.1365-2591.2002.00484.x
8. Manohar MP, Sharma S. A survey of the knowledge, attitude, and awareness about the principal choice of intracanal medicaments among the general dental practitioners and nonendodontic specialists. Indian J Dent Res. 2018 Nov 1;29(6):716.
9. Noor SSSE, S Syed Shihaab, Pradeep. Chlorhexidine: Its properties and effects [Internet]. Vol. 9, Research Journal of Pharmacy and Technology. 2016. p. 1755. Available from: http://dx.doi.org/10.5958/0974-360x.2016.00353.x
10. Siddique R, Sureshbabu NM, Somasundaram J, Jacob B, Selvam D. Qualitative and quantitative analysis of precipitate formation following interaction of chlorhexidine with sodium hypochlorite, neem, and tulsi. J Conserv Dent. 2019 Jan;22(1):40–7.
11. Rajendran R, Kunjusankaran RN, Sandhya R, Anilkumar A, Santhosh R, Patil SR. Comparative Evaluation of Remineralizing Potential of a Paste Containing Bioactive Glass and a Topical Cream Containing Casein Phosphopeptide-Amorphous Calcium Phosphate: An in Vitro Study. Pesqui Bras Odontopediatria Clin Integr [Internet]. 2019;19. Available from: http://www.scielo.br/scielo.php?pid=S1983-46322019000100364&script=sci_arttext
12. Nandakumar M, Nasim I. Comparative evaluation of grape seed and cranberry extracts in preventing enamel erosion: An optical emission spectrometric analysis. J Conserv Dent. 2018 Sep;21(5):516–20.
13. Hussainy SN, Nasim I, Thomas T, Ranjan M. Clinical performance of resin-modified glass ionomer cement, flowable composite, and polyacid-modified resin composite in noncarious cervical lesions: One-year follow-up. J Conserv Dent. 2018 Sep;21(5):510–5.
14. Ravinthar K, Jayalakshmi. Recent Advancements in Laminates and Veneers in Dentistry [Internet]. Vol. 11, Research Journal of Pharmacy and

Technology. 2018. p. 785. Available from: http://dx.doi.org/10.5958/0974-360x.2018.00148.8

15. Gutmann JL, Lovdahl PE. Problem Solving in Endodontics - E-Book: Prevention, Identification and Management. Elsevier Health Sciences; 2010. 496 p.
16. Iqbal MK, Kohli MR, Kim JS. A retrospective clinical study of incidence of root canal instrument separation in an endodontics graduate program: a PennEndo database study. J Endod. 2006 Nov;32(11):1048–52.
17. Sattapan B, Nervo G, Palamara J, Messer H. Defects in Rotary Nickel-Titanium Files After Clinical Use [Internet]. Vol. 26, Journal of Endodontics. 2000. p. 161–5. Available from: http://dx.doi.org/10.1097/00004770-200003000-00008
18. Haikel Y, Gasser P, Allemann C. Dynamic fracture of hybrid endodontic hand instruments compared with traditional files. J Endod. 1991 May;17(5):217–20.
19. Cheung GSP. Instrument fracture: mechanisms, removal of fragments, and clinical outcomes. Endodontic Topics. 2007 Mar;16(1):1–26.
20. Ilan Rotstein DDS, John I. Ingle DDS. Ingle's Endodontics. PMPH USA; 2019. 1326 p.
21. Teja KV, Ramesh S, Priya V. Regulation of matrix metalloproteinase-3 gene expression in inflammation: A molecular study. J Conserv Dent. 2018 Nov;21(6):592–6.
22. Ramamoorthi S, Nivedhitha MS, Divyanand MJ. Comparative evaluation of postoperative pain after using endodontic needle and EndoActivator during root canal irrigation: A randomised controlled trial. Aust Endod J. 2015 Aug;41(2):78–87.
23. Sotokawa T. An analysis of clinical breakage of root canal instruments. J Endod. 1988 Feb;14(2):75–82.
24. Ungerechts C, Bårdsen A, Fristad I. Instrument fracture in root canals - where, why, when and what? A study from a student clinic. Int Endod J. 2014 Feb;47(2):183–90.
25. Tzanetakis GN, Kontakiotis EG, Maurikou DV, Marzelou MP. Prevalence and management of instrument fracture in the postgraduate endodontic program at the Dental School of Athens: a five-year retrospective clinical study. J Endod. 2008 Jun;34(6):675–8.
26. Kumar D, Antony S. Calcified Canal and Negotiation-A Review. Research Journal of Pharmacy and Technology. 2018;11(8):3727–30.
27. Rajakeerthi R, Ms N. Natural Product as the Storage medium for an avulsed tooth--A Systematic Review. Cumhuriyet Dental Journal. 2019;22(2):249–56.
28. Jose J, Subbaiyan H. Different Treatment Modalities followed by Dental Practitioners for Ellis Class 2 Fracture–A Questionnaire-based Survey. Open Dent J [Internet]. 2020; Available from: https://opendentistryjournal.com/VOLUME/14/PAGE/59/FULLTEXT/
29. Nagai O, Tani N, Kayaba Y, Kodama S, Osada T. Ultrasonic removal of broken instruments in root canals. Int Endod J. 1986 Nov;19(6):298–304.
30. Nimet G, Dilek H. Comparison of different techniques to remove fractured Endodontic Instruments From Root Canal System. Eur J Dent. 2009;3:90–5.
31. Hulsmann M. Methods for removing metal obstructions from the root canal [Internet]. Vol. 9, Dental Traumatology. 1993. p. 223–37. Available from: http://dx.doi.org/10.1111/j.1600-9657.1993.tb00278.x
32. McGuigan MB, Louca C, Duncan HF. Endodontic instrument fracture: causes and prevention. Br Dent J. 2013 Apr;214(7):341–8.