|| ISSN(online): 2589-8698 || ISSN(print): 2589-868X ||
International Journal of Medical and Biomedical Studies
Available Online at www.ijmbs.info
PubMed (National Library of Medicine ID: 101738825)
Index Copernicus Value 2018: 75.71
Original Research Article
Volume 4, Issue 3; March: 2020; Page No. 116-121

CLINICAL APPROACH TO THE MANAGEMENT OF FRACTURED INSTRUMENTS USING ULTRASONICS AND THE INSTRUMENT RETRIEVAL SYSTEM UNDER THE DENTAL OPERATING MICROSCOPE

Rohan Gupta[1], Tanya Sharma[2], NSC Charles[3], RPS Bedi[4]
[1]MDS, Conservative Dentistry and Endodontics, Rajouri, J & K
[2]BDS, Dentist, Pattan, J & K
[3]MDS, Oral and Maxillofacial Pathology, HOD, Jammu
[4]MDS, Orthodontics and Dentofacial Orthopaedics, HOD, Meerut

Article Info: Received 18 February 2020; Accepted 18 March 2020
DOI: https://doi.org/10.32553/ijmbs.v4i3.1029
Corresponding author: Rohan Gupta
Conflict of interest: No conflict of interest.

Abstract

Background: Instrument separation has become a major concern in the endodontic practice today. In cases where the fractured fragment completely blocks the canal, the access of disinfecting irrigants to the root canal system is limited. Literature suggesting the guidelines on the management of broken instruments is scanty. This study was aimed to establish a preliminary guideline in the management of cases with instrument fracture using the Ultrasonic tips, the Instrument Retrieval System (IRS) and Instrument bypass under the Dental Operating Microscope (DOM).

Methods: 40 cases were selected with fractured instruments and categorized as follows-location coronal or apical to curvature- size of greater than or less than 5 mm. Patients were informed about the procedure and its complications, following which consent was taken. Management was planned in three stages. Instrument retrieval with the aid of Ultrasonics was performed under the DOM in stage 1. Retrieval using IRS was performed in stage 2. Instrument bypass was performed in stage 3. Success rate was compared using statistical analysis by the StatPac software.

Results and conclusion: Fractured fragments with a length of less than 5mm and straight line access was retrieved successfully under the DOM using the Ultrasonics in 87.5% cases. Retrieval of fragments greater than 5mm and with a straight line access was successful with the added use of the Instrument Retrieval system/ Instrument extractor in 71.4% cases.

Keywords: Ultrasonic, Instrument Retrieval System, Dental Operating Microscope, instrument bypass, fractured instrument

Key Message: Instrument fracture in an endodontic practice is a stressful event. With the widespread use of rotary instruments, the incidence of instrument separation has increased. With increasing referral of such cases, management of these cases with a predictable outcome has become important in endodontic specialty. An attempt has been made to lay down guidelines regarding management of cases with fractured instruments.

Introduction

The current root canal preparation technique uses Stainless Steel and Nickel Titanium instruments. There have been incidences of instrument fracture within the root canal system which compromises the treatment outcome[1]. The cause of instrument breakage is often torsional and/ or cyclic fatigue[2]. The objective symptoms following an instrument breakage are often delayed and may not lead to immediate intervention. A fractured instrument significantly affects the treatment outcome when it completely blocks the canal where further cleaning and shaping procedures are prevented [3].

The prognosis of the treatment following an instrument fracture largely depends on the stage of root canal preparation in which the instrument sustained a fracture, the location of the fragment, the location of the root canal curvature with respect to the fragment and the length of the fragment, the presence of preoperative vitality and the absence of periapical pathology [3,4,5].

Literature suggests the incidence of instrument fracture to be reported in 0.7-7% of cases[6,7,8,9]. The clinical approach to management of such cases should be based on thorough knowledge of the success rate of each treatment option available and to inform the patient preoperatively of the options and risks of treatment as part of the consent procedure. Literature suggests that the fractured instruments can be removed by a variety of methods such as fine ultrasonic tips, micro-tubule devices and pliers/haemostatic forceps[10,11,12]. As removal of a fractured file is associated with considerable risk in a few cases, bypassing the fragment should also be considered a treatment option.

The current study uses the different techniques for the purpose of broken instrument retrieval, instrument bypass

in cases where the instrument is not retrieved by other methods.

Materials & Methods:

40 Patients referred to tertiary health care centre from 2014-2017 with intracanal broken instrument/s were selected for management in three stages: 1. Using Ultrasonics. 2. Using Instrument Retrieval System (IRS) 3. Bypassing the fractured instrument. All the stages were carried under the Dental Operating Microscope (DOM). Statistical analysis was made using the StatPac software (Copyright © 2017 StatPac Inc.) using one-sample t-test and two-sample t-test to determine the efficacy of each technique.

Inclusion criteria- Previously treated Root canal cases with single/ multiple fractured instruments. Slight (≤5º) to moderate (5º–20º) angle of root curvature. Exclusion criteria- Cases with severely curved roots (≥20º), fracture, calcification or resorption.

Primarily the coronal third of the canals containing the fractured fragment were slightly modified using a modified Gates Glidden drill (The tip blunted using a diamond bur) and an Ultrasonic Endodontic ET20D tip available by Satalac using Satalac Suprasson P5 Booster scaler at a power setting of 4. This was done to obtain a straight line access to the fractured fragment. The separated instrument(s) was/were visualized with the help of a DOM (HS-Moller-Wedel International) at 8x and 16x. A DG-16 explorer (GDC) was used to confirm the straight line access to the instrument. 17% EDTA solution (Prevest Denpro) was placed in the canal using a 30 gauge needle and immediately aspirated using the same, making sure the canal was wet and not overfilled in order to avoid hindrance in vision, following which staging was performed using an Ultrasonic Endodontic ET40 tip at a power setting of 4 by placing and activating it alongside the instrument circumferentially in the anticlockwise direction under the DOM. EDTA was used as an intermittent coolant to avoid overheating as well as aid in lubrication. Recent studies suggest use of olive oil to be better than EDTA because of favorable viscosity[13]. The Ultrasonic tip was used for less than 1 minute during each activation. Following staging, using the same tip at a power setting of 5, the Ultrasonic tip was placed in contact with the instrument and activated. Successful retrieval of the fractured fragments was accomplished.

Ruddle described in his article the use of Ultrasonic tips and the IRS[12]. (The current system of IRS available by San Diago Swiss endo- consists of three core drill and four microtubes with internal screw wedges of different diameters) for successful retrieval of the fractured fragments. In cases where the straight line access was confirmed using the core drill available with the IRS, the same was used to expose around 3mm of dentin circumferentially in the coronal aspect of the fractured instrument by moving in a clockwise direction. The instrument extractor available with the IRS system was chosen corresponding to the closest size of the coronal aspect of the broken instrument. The instrument extractor was made to reach the instrument and the lumen slightly tilted for the fragment to lodge in the space available following which it was locked using the screw wedge by moving the latter in an anticlockwise direction. The instruments were subsequently retrieved.

Bypassing a fractured instrument is a tedious process. In some cases where the fractured fragment does not completely obliterate the canal, it can easily be bypassed using a stiff instrument. A hand instrument with a high buckling resistance is preferred. In cases where the instrument completely obliterates the canal, manual creation of path around the instrument is required, increasing the chairside time and often frustration on the clinicians part. A thorough examination of the retained instrument fragment under the DOM is often useful, which indicates the path which can be used to enter the instrument beyond the fragment. Instruments greater than 5mm of length & without a straight line access and those which were tightly screwed into the canal were considered to be an un-favorable factor for instrument bypass[13].

Results:

40 patients with intracanal broken instrument(s) were selected for management using different techniques. Instrument fracture was observed in 37.5 % cases to be coronal to the curvature and in 62.5% (25 out of 40) cases to be beyond the curvature (where straight line access to the instrument was not possible. A one-sample t-test between proportions was performed to determine whether there was a significant difference between the percent of instruments fractured coronal to the apex and those fractured apical to the apex. The t-statistic was not significant at the .05 critical alpha level, $t(39)=1.633$, $p=.1105$. Therefore, it was concluded that the difference between the number of instruments fractured coronal and those fractured apical to the curvature was not significant.

A total of 10 instruments were retrieved in Stage 1 using Ultrasonics under DOM. Ultrasonics was found to be more effective when used for the fragments located coronal to the curvature when compared to those located apically (46.7% vs 12%)(Table 1). A two-sample t-test between proportions was performed and a significant difference between fragments retrieved using Ultrasonics located coronal to the curvature and those located apical to the curvature was observed. The t-statistic was significant at the .05 critical alpha level, $t(38)=2.453$, $p=.0189$. Fractured fragments with a length of less than 5mm and with a straight line access could be retrieved under the DOM

using the Ultrasonics alone in 7 out of 8 cases (87.5%), (Table 2).

A total of 6 instruments were retrieved in Stage 2 using the IRS. Instrument extractor/IRS was found to be more effective when used for the fragments located coronal to the curvature when compared to those located apically (62.5% vs. 4.55%)(Table 1). A two-sample t-test between proportions was performed and a significant difference between fragments retrieved using IRS/Instrument extractor located coronal to the curvature and those located apical to the curvature was observed. The t-statistic was significant at the .05 critical alpha level, t (28)=3.509, p=.0015.Retrieval of fragments greater than 5mm and with a straight line access was enhanced with the added use of the Instrument Retrieval system/ Instrument extractor in 5 out of 7 cases (71.4%), (Table 2). A total of 14 instruments were bypassed in Stage 3. Instrument bypass was found to be more effective as compared to instrument retrieval technique when used for the fragments located apical to the curvature(57.1% vs. 16%)(Table 1). A one-sample t-test between proportions for the fragments located apical to the curvature was performed and a significant difference between fragments bypassed and fragments retrieved was observed. The t-statistic was significant at the .05 critical alpha level, t (44) =2.916, p=.0056. Fractured fragments with a length of less than 5mm and located apical to the curvature, after the instrument retrieval procedure failed, were bypassed under the DOM successfully, in 10 out of 13 cases (76.9%), (Table 2).

Management of fragments of greater than 5mm length and without a straight line access was considered to be the most unfavorable. Neither instrument retrieval nor bypass could be performed in 6 out of 9 cases (66.67%), (Table 2).

Instrument retrieval for stainless steel instruments were more favorable as compared to the Nickel Titanium instruments because of heat development in the later during the process of retrieval using Ultrasonics which lead to further fracture of the fragment. Fractured fragments beyond the curvature were considered to be unfavorable because of large amount of dentinal loss during retrieval. Instrument bypass was found to be a viable option in such cases.

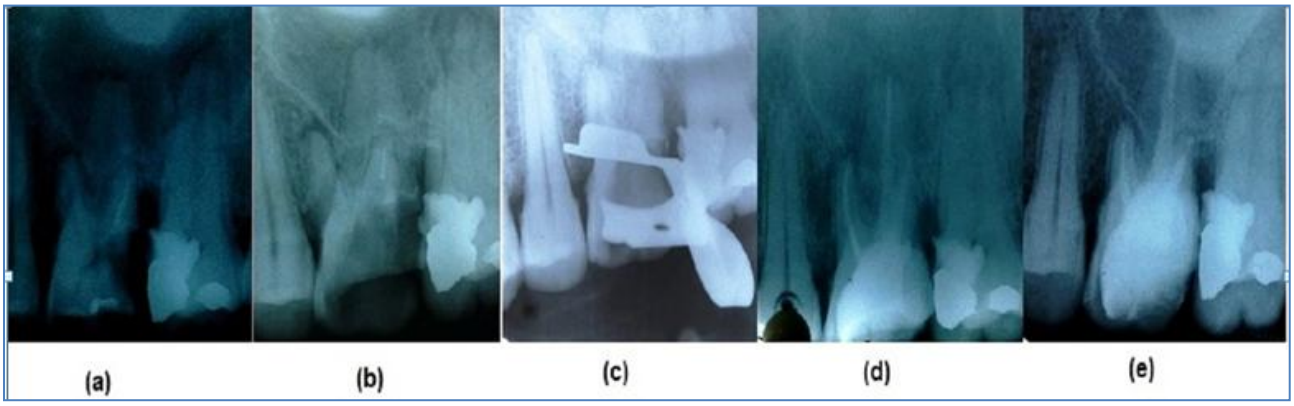


Figure 1: Case of 2 fractured K-files in DB root of 16. (Both<5mm- Retrieved using Ultrasonics)
(a) Preoperative (b) Coronal K file removed (c) Apical K file removed (d) Obturation (e) Followup-1 year

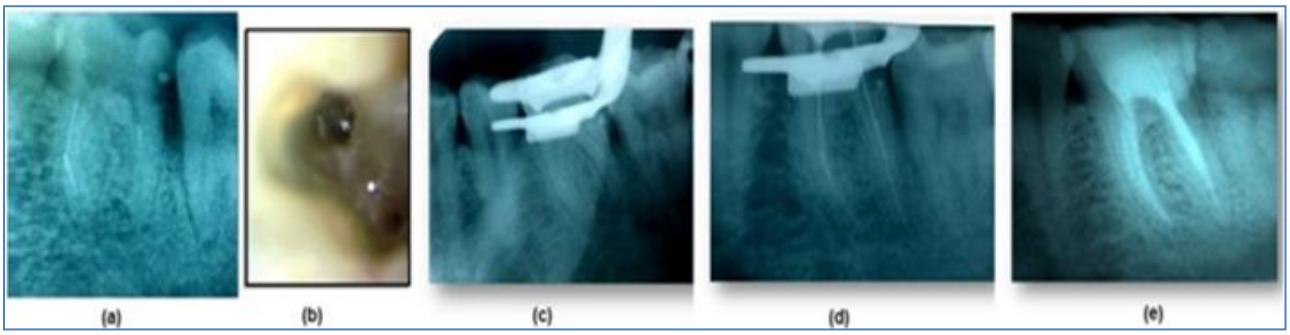


Figure 2: Case of 2 fractured K-files- above curvature, 1 NiTi file- beyond curvature. (All<5mm- 2 Retrieved using Ultrasonics, 1 bypassed)

(a) Preoperative (b) Clinical picture using DOM (c) Coronal K files removed (d) NiTi file bypassed (e) Postoperative-1 year

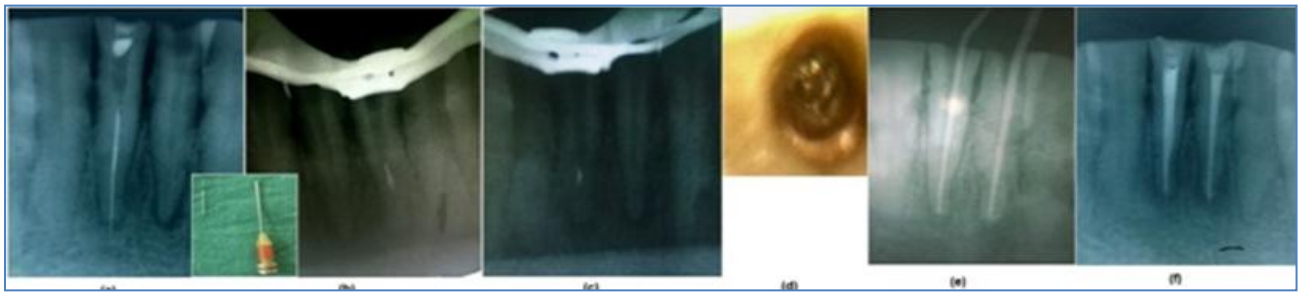


Figure 3: Case of 3 fractured K-files (One>5mm- Retrieved using IRS, Two<5mm- 1 Retrieved using Ultrasonics, 1 bypassed)

(a) Preoperative (b) Retrieved using IRS (c) Retrieved using Ultrasonics (d) Clinical picture using DOM (c) Fragment bypassed (d) Postoperative-1 year

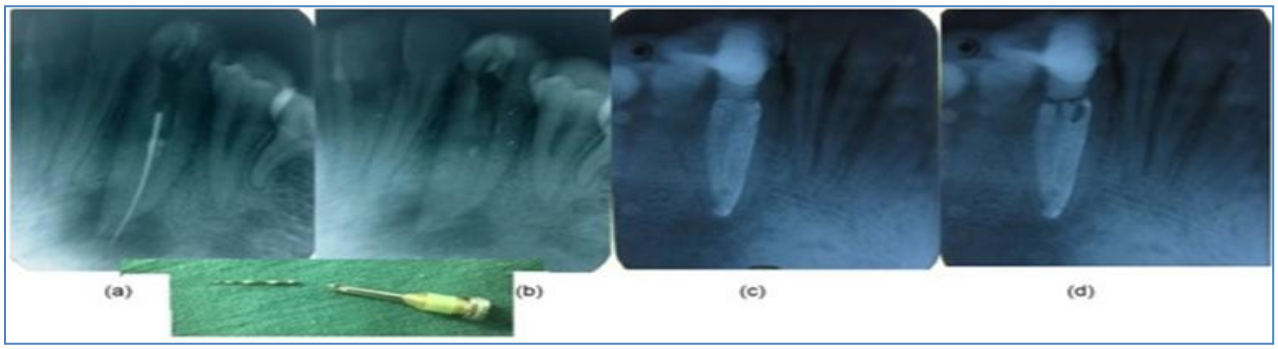
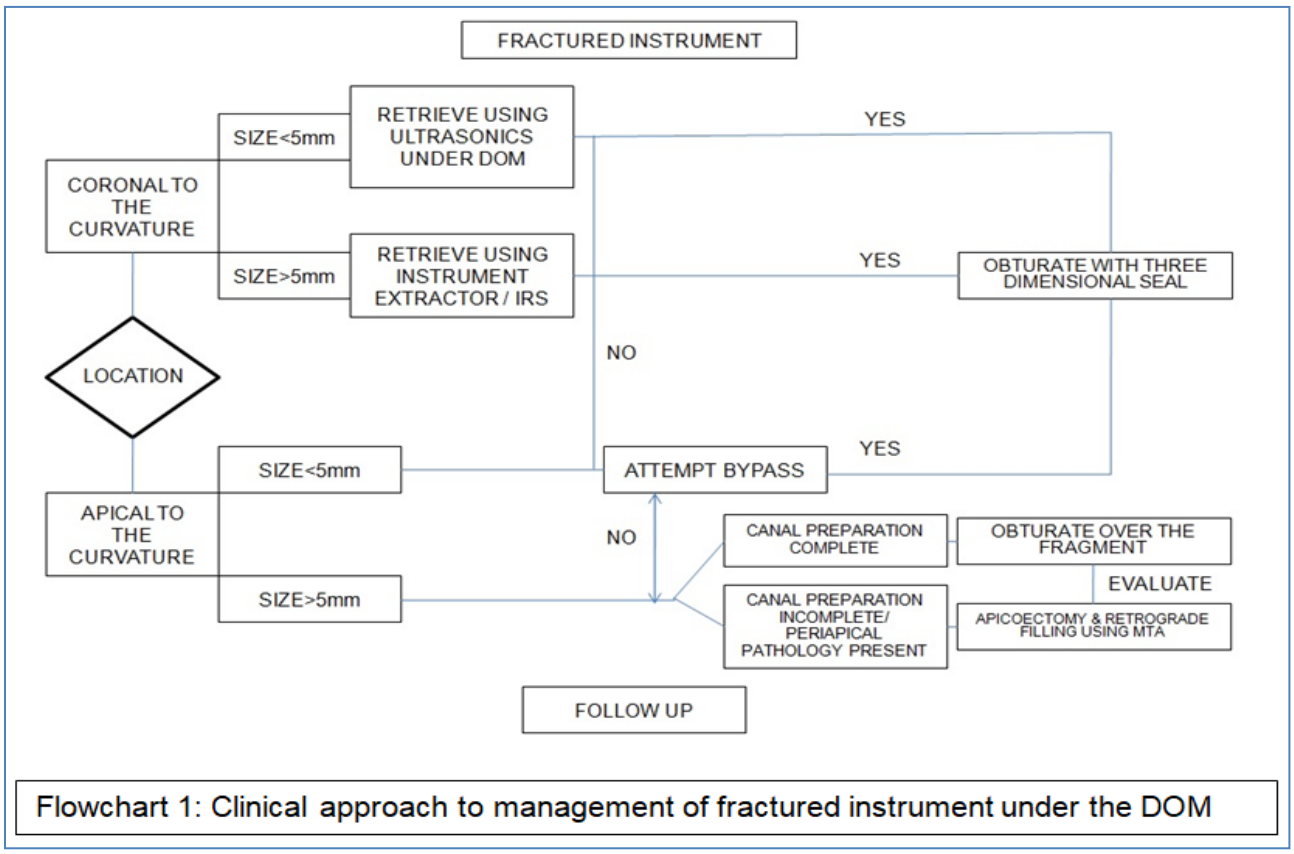


Figure 4: Case of fractured NiTi-file (>5mm- Retrieved using IRS)
(a) Preoperative (b) Retrieved using IRS (c) Obturation using MTA (d) Postoperative-1 year



Flowchart 1: Clinical approach to management of fractured instrument under the DOM

Table 1: Stages of management of fractured instruments

Total cases n=40	Stage 1: Instrument retrieval using Ultrasonics (10)	Stage 2: Instrument retrieval using IRS/ Instrument Extractor (6)	Stage 3: Instrument Bypassed (14)	Could neither be retrieved nor bypassed (10)
CORONAL TO CURVATURE (n=15)	7 (46.7%) (n=15)	5 (62.5%) (n=8)	2 (66.67%) (n=3)	1 (6.7%) (n=15)
APICAL TO CURVATURE (n=25)	3 (12%) (n=25)	1 (4.55%) (n=22)	12 (57.1%) (n=21)	9 (36%) (n=25)

Table 2: Success rate of management of fractured instruments using different techniques

LOCATION	CORONAL TO THE CURVATURE		APICAL TO THE CURVATURE		TOTAL CASES
SIZE	<5 mm	>5 mm	<5 mm	>5 mm	(n)
NUMBER OF CASES	8	7	16	9	40
	37.5%		**62.5%**		
RETRIEVED USING ULTRASONICS	7	0	3	0	10
	70%	0%	30%	0%	
RETRIEVED USING INSTRUMENT EXTRACTOR/ IRS	0	5	0	1	6
	0%	**83.3%**	0%	16.7%	
INSTRUMENT BYPASSED	1	1	10	2	14
	7.1%	7.1%	**71.4%**	14.3%	
COULD NEITHER BE RETRIEVED NOR BYPASSED	0	1	3	6	10
	0%	10%	30%	**60%**	

Discussion:

Almost every clinician into endodontic practice has experienced instrument fracture during root canal treatment. The development of apical periodontitis indicates contamination of the root canal space. Often, it may not be wise to wait for the periapical pathology to develop but to intervene immediately. No standardized protocol for the removal/bypass of intracanal obstructions have been established in the literature.

Management of selected cases was done in the present study in three stages. Stage I consisted of instrument retrieval using the Ultrasonics. Fractured fragments with a length of less than 5mm and with a straight line access could be retrieved under the DOM using the Ultrasonics alone in 87.5% cases in the present study. In a similar study by Alomairy in 2009, 80% of the instruments present in the straight part of the canal were removed by this technique[14].

Stage II consisted of instrument retrieval using the IRS. Retrieval of fragments greater than 5mm and with a straight line access was enhanced with the added use of the Instrument Retrieval system/ Instrument extractor in 71.4% cases in the present study. Similar studies have shown that Intracanal fragments with lengths > 5 mm have been removed successfully from straight to moderately curved canals using the IRS / Instrument extractor.[14, 16]

In cases where attempt to remove the intracanal fragment with ultrasonic tips and IRS failed, no further attempt using this method was made to avoid the risk of excessive dentine removal thus preventing vertical root fracture resistance loss[17,18].

Stage III consisted of management by bypassing the fractured fragment. Studies have shown that this procedure allows effective management of a small fragment located near the coronal third, middle third of the root canal or those beyond a curvature. However, it is difficult to manage a larger (>5mm) and more apically located/ tightly screwed fragment using this technique.[16, 18] Fractured fragments with a length of less than 5mm and located apical to the curvature, after the instrument retrieval procedure failed, were bypassed under the DOM successfully in 76.9% cases in the present study. This procedure can be used in a tooth demonstrating preoperative vitality with a favorable prognosis but not in cases with periapical diseases where three dimensional seal is not possible[19].

It was noted in the study that the smaller fragments occasionally break off from a NiTi instrument more than that in stainless steel instrument by heat generated through ultrasonic vibration, leaving a shorter fragment in the root canal, which is more difficult to remove[20]. Retrieval of fractured instruments in severely curved canals(>20º) are extremely challenging according to the literature and not advocated clinically considering the amount of dentinal loss, which causes reduced root strength of up to 40% according to a study by Madarati *et al*[21].

The management of cases with fractured instruments is difficult and time-consuming, and the success rate can be quite variable. In this study, the success was defined as the complete removal of the fractured instrument or bypassing the fragment without creating a root perforation; the overall success rate was 75% (n=40).

Summary and Conclusion:

Instrument separation in the root canal system is an iatrogenic error that should be minimized to the lowest extent possible. In cases where the event has occurred, successful management is important. This study aims to

serve as a primary guideline for clinical approach to management of fractured instrument cases. In cases where the instrument has broken in the coronal third with straight line access, retrieval is the treatment of choice. Instrument of size less than 5mm can solely be retrieved using Ultrasonics, greater than 5mm with additional use of IRS. Instrument fractured in middle/apical third where straight line access is not possible should preferably be bypassed. If bypass/ three dimensional seal following bypass is not possible, endodontic surgery using retrofilling with MTA (or Biodentine) should be considered, and case to be followed up. In cases showing preoperative vitality, with instrument fractured in apical third where cleaning and shaping was completed and instrument completely obliterates the canal, instrument can be kept as a part of the root canal filling and root canal space coronal to it can be filled, case to be followed up. Cases where fractured fragment extrudes beyond the apex should be managed surgically if all other techniques of retrieval fail.

Drawback of the study

The cases reported with fractured instruments are less in clinical scenario, so cases in the present study were taken up by means of referral only. Further studies with larger sample size can be done.

References:

1. Spili P, Parashos P, Messer HH: The impact of instrument fracture on outcome of endodontic treatment, J Endod 31:845, 2005.
2. Sattapan B, Nervo GJ, Palamara JEA, et al. Defects in rotary nickel-titanium files after clinical use. J Endod 2000;26:161–5.
3. Fors UGH, Berg JO. A method for the removal of broken endodontic instruments from root canals. J Endod 1983;9:156–9.
4. Torabinejad M, Lemon RR. Procedural accidents. In: Walton RE, Torabinejad M, eds. Principles and practice of endodontics. 3rd ed. Philadelphia: W.B. Saunders Company; 2002:310–30.
5. Hulsmann M, Schinkel I. Influence of several factors on the success or failure of removal of fractured instruments from the root canal. *Endod Dent Traumatol* 1999;15:252–258.
6. Crump M C, Natkin E. Relationship of a broken root canal instrument to endodontic case prognosis: a clinical investigation. *J Am Dent* 1970; 80: 1341–1347.
7. Parashos P, Messer H H. Rotary NiTi instrument fracture and its consequences. *J Endod* 2006; 32: 1031–1043.
8. Bergenholtz G, Lekholm U, Milthon R, Heden G, Ödesjö B, Engström B. Retreatment of endodontic fillings. *Scand J Dent Res* 1979; 87: 217–224.
9. Spili P, Parashos P, Messer H H. The impact of instrument fracture on outcome of endodontic treatment. *J Endod* 2005; 31: 845–850.
10. Kleier DJ, Mendoza M. The use of tungsten carbide needle holders to remove intracanal objects. J Endod 1996;22:703-705.
11. Suter B. A new method for retrieving silver points and separated instruments from root canals. J Endod 1998;24:446-448.
12. Ruddle CJ. Broken instrument removal. The endodontic challenge. Dent Today 2002;21:70–2, 74, 76.
13. Terauchi Y, O'Leary L, Suda H. Removal of separated files from root canals with a new file-removal system: case reports. J Endod 2006;32:789-797.
14. Khalid H. Alomairy. Two Techniques to Remove Fractured Rotary Ni-Ti Instruments from Root Canals. JOE — Volume 35, Number 4, April 2009
15. Gerek M, Başer ED, Kayahan MB, Sunay H, Kaptan RF, Bayırlı G. Comparison of the force required to fracture roots vertically after ultrasonic and Masserann removal of broken instruments. Int Endod J 2012;45:429-434.Parashos P, Messer HH. Rotary NiTi instrument fracture and its consequences. J Endod 2006:32:1031-1043.
16. Nevares G, Cunha RS, Zuolo ML, Bueno CE. Success rates for removing or bypassing fractured instruments: a prospective clinical study. J Endod 2012; 38:442-444.
17. Madarati AA, Qualtrough AJ, Watts DC. Vertical fracture resistance of roots after ultrasonic removal of fractured instruments. Int Endod J 2010;43:424-429.
18. Panitvisai P, Parunnit P, Sathorn C, Messer HH. Impact of a retained instrument on treatment outcome: a systematic review and metaanalysis. J Endod 2010;36:775-780.
19. Parashos P, Messer HH. Rotary NiTi instrument fracture and its consequences. J Endod 2006:32:1031-1043.
20. Shen Y, Peng B, Cheung GS. Factors associated with the removal of fractured NiTi instruments from root canal systems. Oral Surg Oral Med Oral Pathol Oral Radiol Endod 2004;98:605-610.
21. Madarati AA, Hunter MJ, Dummer PM. Management of intracanal separated instruments. J Endod 2013;39:569-581