

Endodontic management of mandibular premolars with three root canals: Case series
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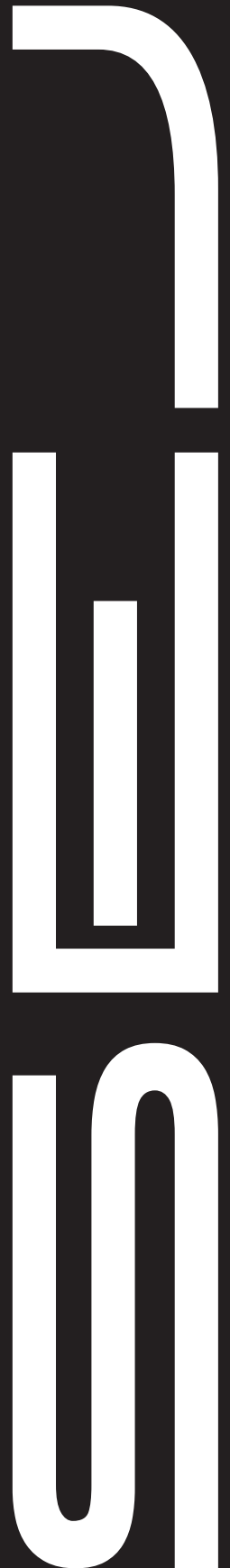
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Retrieval outcome of separated endodontic instruments by Saudi endodontic board residents: A Clinical retrospective study

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Abstract

Aim: This study aims to evaluate the retrieval outcome of the separated endodontic instrument by endodontic board residents.

Materials and Methods: Records of 450 endodontic cases with separated endodontic instruments treated by endodontic Saudi board residents were randomly selected. The evaluation was based on the tooth type, type of fractured instrument, incidence and anatomical location in the root canal and if the instrument was retrieved, bypassed, or left. Data were statistically analyzed using IBM-SPSS.22.

Results: A total of 84 (19%) separated instruments were identified. Thirty-four cases (7.55%) with separated instruments out of the total evaluated cases were done by residents. The incidence between hand stainless steel and nickel-titanium instruments was statistically significant ($P < 0.05$). The separated instruments were found more in the mandibular molars, i.e., 44 (52.4%). They were observed more in the buccal canal of the maxillary premolars and mesiobuccal canals of mandibular and maxillary molars. Fifty-seven (67.9%) of the separated fragments were located in the apical third of the root. Thirty-six (34.3%) were retrieved, 20 (19.0%) were bypassed, and 34 (32.4%) were left while 15 (14.3%) were managed by surgery. The ultrasonic device was more active in removing the separated instruments.

Conclusions: Regardless of little experience of the endodontic residents, they were successfully managed to remove or bypass most of the separated instruments. Ultrasonic device was very helpful in removing the separated instrument.

Keywords: Bypass, endodontic residents, instrument retrieval, separated endodontic instrument

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INTRODUCTION

Complete cleaning and filling of the entire root canal system is very important objective for a successful outcome of the root canal therapy. Alhekeir *et al.* identified 68%

endodontic mishaps during root canal treatment by senior dental students in government and private schools.^[1] Most of the mishaps occurred in the posterior teeth with curved roots.

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Separation of the endodontic instrument usually occurs when dealing with complicated canal morphology. The chances for healing periapical pathosis will be reduced if the separated instrument is retained in infected canal.^[2]

The incidence of separation of stainless steel (SS) instruments ranged between 2% and 6%^[3,4] while separation of the nickel-titanium (NiTi) instruments reached up to 9.4% despite their superelasticity.^[5]

Several factors could lead to instrument separation including torsional and cyclic fatigue, instrument design and composition, canal configuration, root canal preparation technique, and the number of use.^[3,6]

The SS instrument usually shows sign of distortion before separation while NiTi instruments separate without warning.^[7-9]

Repeated usage of the NiTi instrument will cause metal fatigue. The torsional and fatigue of the NiTi alloy will lead to instrument separation due to locking of the instrument tip in the root canal during instrument rotation or when facing severe curvature.^[6,9,10]

The attempts to remove retained separated endodontic instruments have been reported in several clinical studies and series of case reports using different methods and specialized devices such as ultrasonic devices, instrument removal system, and Masseran kit.^[3,11,12]

In Kingdom of Saudi Arabia, a 4-year endodontic program “the Saudi board of Endodontics” known as the Saudi Specialty Certificate in Endodontics (SSC-Dent [Endo]) provided by the Saudi Commission for health specialties was established 10 years ago. This program attracted the young dental graduates who wished to improve their skillfulness, experience, and knowledge in clinical endodontics. The program offers didactic (basic and clinical sciences) and advanced clinical training. In addition to this program, three universities provided a master program that closely adheres to international standards. The SSC-Dent (Endo) program provided more clinical training and accepted more number of candidates compared to the three master programs.^[13]

Due to the large number of cases treated by the endodontic board residents, we believe that it is worth of investigating the ability of the residents in managing the separated instruments; therefore, the aim of this study was to evaluate the retrieval outcome of the separated endodontic instrument by endodontic board residents.

MATERIALS AND METHODS

Records of 450 out of 1640 endodontic cases treated by endodontic Saudi board residents from October 2000 to May 2015 were randomly selected. Cases of separated endodontic instruments retained in the root canal or retrieved were evaluated. The evaluation was based on the tooth type, type of fractured instrument, incidence and anatomical location in the root canal and if the instrument was retrieved, bypassed, or left. The type of separated instrument, SS or NiTi, and the method used to deal with the broken instrument were recorded by the treating resident or the referring dentist.

Ethics approval was obtained from the chairman of the scientific committee of the Saudi Board of Endodontic. Data were statistically analyzed using IBM-SPSS 22 (Chicago, IL, USA).

RESULTS

A total of 84 (19%) separated instruments (58 hand SS files and 26 rotary NiTi) were identified [Table 1]. Fifty (60%) were referred by general practitioners (GP), and 34 (40%) were separated by residents during treatment [Table 2]. Most of the hand SS files were referred by GP. In contrast, all the NiTi rotary instruments were separated by SSC-Dent (Endo) residents. The 34 identified teeth with separated instruments done by residents represent 7.55% of the total evaluated cases. The incidence between hand SS and NiTi instruments was statistically significant ($P < 0.05$).

The separated instruments (SS and NiTi) were found more in the mandibular molars 44 (52.4%) followed by maxillary molars 17 (20.2%) and premolars with 17 (20.2%) where no separated instruments were encountered in the mandibular anterior teeth [Table 1]. They were observed more in the buccal canal of the maxillary premolars and mesiobuccal canals of mandibular and maxillary molars [Tables 3 and 4].

Of the 84 separated instruments, 13 (15.5%) were separated in full length, 57 (67.9%) in the apical third, 12 (14.3%) in the middle third, and 2 (2.4%) in the coronal third of the root canals [Table 2]. Thirty-six (34.3%) were retrieved, 20 (19.0%) were bypassed, and 34 (32.4%) were left while 15 (14.3%) were managed by surgery. The ultrasonic device was more active in removing the separated instruments [Table 3].

DISCUSSION

The overall incidence of instrument separation reported by SSC-Dent (Endo) residents in this study is 7.55%. It is quite high compared to Iqbal *et al.*'s^[14] study who reported 1.67%

Table 1: Type of separated instrument identified

Tooth type	Type of instrument		Total (%)	Preoperative P value comparing column
	Hand SS	NiTi		
Maxillary anteriors	5	1	6 (7.1)	<0.05
Mandibular anteriors	0	0	0	<0.05
Maxillary premolars	12	5	17 (20.2)	<0.05
Mandibular premolars	0	0	0	<0.05
Maxillary molars	13	4	17 (20.2)	<0.05
Mandibular molars	28	16	44 (52.4)	<0.05
Total	58	26	84 (100.0)	<0.05
χ^2		1.633		
df		3		
P		0.652		

SS: Stainless steel, NiTi: Nickel-titanium

Table 2: Distribution of the separated instruments according to tooth type, site, incidence, and retrieval outcome (n=450)

Tooth type	Level (site)			Incidence			Outcome				Grand Percentage total	χ^2	df	P	
	Full length	Coronal	Middle	Apical	Referred	Dx	Left	Retrieved	Bypass	Surgery					
Maxillary anteriors	3	0	0	3	3	3	1	5	4	0	6	7.1	14.529	2	0.001
Mandibular anteriors	0	0	0	0	0	0	0	0	0	0	0	0.0			
Maxillary premolars	0	1	0	16	13	4	9	3	2	5	17	20.2			
Mandibular premolars	0	0	0	0	0	0	0	0	0	0	0	0.0			
Maxillary molars	0	0	2	15	7	10	9	5	7	2	17	20.2			
Mandibular molars	10	1	10	23	27	17	15	24	7	5 + (3*)	44	52.4			
Total	13	2	12	57	50	34	34	36	20	15	84	100.0			
Percentage	15.5	2.4	14.3	67.9	59.5	40.5	32.4	34.3	19.0	14.3					
χ^2		22.984			4.689			18.363							
df		3			3			9							
P		0.006			0.196			0.031							

*Extracted. Dx = During treatment

Table 3: Distribution of the separated instruments in molar teeth according to canal location, site, and technique of instrument removal

Tooth	Location (canal)					Level (site)				Technique of removing the instrument			
	MB	ML	DB	DL	P	Full length	Coronal	Middle	Apical	Bypass	Ultrasonic device	Pliers and forceps	Extraction device
Maxillary first molars	5	0	4	0	2	0	0	2	9	5	1	0	1
Maxillary second molars	4	0	0	0	2	0	0	0	6	2	2	0	0
Mandibular first molars	15	7	2	7	0	10	1	6	14	5	8	0	6
Mandibular second molars	8	2	0	3	0	0	0	4	9	2	4	0	0
Total	32	9	6	10	4	10	1	12	38	14	15	0	1
Percentage	52.5	14.8	9.8	16.4	6.6	16.4	1.6	19.7	62.3	46.7	50.0	0.0	3.3
χ^2		30.112				16.25				8.56			
df		12				9				6			
P		0.003				0.062				0.201			

MB: Mesiobuccal, ML: Mesiolingual, DB: Distoobuccal, DL: Distolingual

Table 4: Distribution of the separated instruments in maxillary premolar teeth according to canal location, site, and technique of instrument removal

Tooth	Location (canal)			Level (site)				Technique of removing the instrument			
	Buccal	Palatal	Single	Full length	Coronal	Middle	Apical	Bypass	Ultrasonic device	Pliers and forceps	Extraction device
Maxillary first premolars	9	1	0	0	1	0	9	1	0	0	0
Maxillary second premolars	1	1	5	0	0	0	7	1	0	0	0
Total	10	2	5	0	1	0	16	2	0	0	0
Percentage	58.8	11.8	29.4	0.0	5.9	0.0	94.1	100.0	0.0	0.0	0.0
χ^2		11.2			0.788						
df		2			1						
P		0.004			0.388						

among Penn postgraduate students. Graduate students attending the SSC-Dent (Endo) program do not have enough training on NiTi rotary instruments compared to Penn graduate who should complete cleaning and shaping a 30 extracted molars before working on patients. Such training will provide the students enough experience to use the NiTi instruments with confidence.^[10,15]

The SS hand files are used in a clockwise motion until it engages the root canal wall, and then, the instrument is pulled out. According to Grossman,^[16] the amount of torque applied on the instrument when the file engaged the canal wall should be done with care to avoid breakage. In addition, space between the flutes should remain in the same alignment. In the current study, the amount of SS hand file breakage was more than the NiTi. This could be related to excessive use of the instruments by GP putting in mind that an SS instrument is made of rigid metal that resists breakage.

The introduction of NiTi instruments in endodontics was to facilitate root canal instrumentation as well as minimize procedural errors. Their flexibility and superior resistance to torsional fracture are 3 times more than SS counterparts.^[17-19]

Cyclic fatigue and torsional are the primary causes of NiTi instrument separation. In addition, the separation of the NiTi instrument can be affected by number of variables including the technique and number of used as well as the root canal morphology.^[6,14,20]

The separated instruments in the current study occurred more in the mesiobuccal root canals of maxillary and mandibular molars. Similar findings were reported by Hülsmann and Schinkel,^[4] Pruett *et al.*,^[9] Mandel *et al.*,^[10] Iqbal *et al.*,^[14] Suter *et al.*,^[21] and Nevares *et al.*^[22] This is due to the severe curvature of the canal. This is very important to know for better outcome of root canal cleaning.

The degree of canal curvatures was radiographically investigated by Schäfer *et al.*^[23] in 700 extracted teeth. They found that 84% of the examined root canals were curved. This will affect the fracture susceptibility of endodontic instruments due to stress exerted around the curved canal resulting in exceeding the elasticity limit of the instrument.^[9] This should be clinically considered during treatment.

Most of the instruments were separated at the apical third of the canal in the present study due to its small diameter. They were evaluated using conventional radiographs. Rosen *et al.*^[24] reported that SS instrument retained at the apical

third of the root canal is easy to detect radiographically than NiTi due to its material composition. According to Ward *et al.*,^[25] separated instrument is easy to remove if located at or before the curvature.

Leaving the fragment of the instrument in the root canal will complicate the chemomechanical cleansing and filling procedure.^[26] Care should be taken not to perforate or reduce the root strength when attempt is made to bypass or remove the fragmented instrument.

The SS instrument is easy to remove compared to NiTi. The NiTi instrument usually engaged in the root canal if improbably used which renders it difficult to remove if separated due to its high flexibility and elasticity. Furthermore, the NiTi instruments have the tendency to fracture repeatedly when ultrasonic device is used. It is even impossible to remove if separated in the apical third of a curved narrow canal.^[21,25] It was suggested that different materials as well as increasing taper of NiTi instrument compared to SS would practically make it difficult to access and trephine around the coronal aspect of the NiTi instrument and therefore harder to remove.^[27] Hülsmann and Schinkel^[4] reported high success (59%) of SS separated instruments removal or bypass using different techniques. They attributed that to several factors that help retrieval including root anatomy, straight canal, localization, and length of the separated instrument. Following these, parameters will reduce the risk of procedural mishaps. In the current study, no perforation or ledge was reported. If the attempt to remove the separated instrument failed and the instrument was bypassed, cleaning and shaping followed by filling the canal should be performed regardless of the fragment location.

Several methods and devices including ultrasonic, pliers, and microtube have been tried to remove the separated instrument with varying success rate. Suter *et al.*^[21] used variety of techniques to remove the separated fragments with the aid of dental operating microscope (DOM). They were successfully managed to remove 87% of the fragments. The vibration of the ultrasonic tip is used to loosen the separated instrument. An extensive cutting of the dentinal wall of the root canal is required to create a straight-line access to clearly visualize the separated instrument. In the present study, the ultrasonic device was found to be more active in removing the separated instrument compared to other methods ($P = 0.201$). Care should be taken to avoid root perforation. The use of the DOM is very helpful throughout the procedure to inspect the instrument and to avoid mistake that might jeopardize the outcome.^[21,25,28] The DOM was not available to all residents. Only few

use it where success in removing the instrument fragment was achieved.

Hülsmann and Schinkel^[4] considered a complete bypassing separated instrument is successful treatment. This is true if the operator managed to clean and fill the entire canal length. Infection of the canal with the presence of the fragment could lead to unpredictable prognosis.

In the current study, 19% of the separated fragments were bypassed. This is very low compared to Nevares *et al.*,^[22] Ward *et al.*,^[25] and Souter and Messer^[28] who reported a 56.7%, 67%, and 70% success, respectively. This might be related to the little practical experience of the resident.

Report of earlier studies showed that the prognosis of root canal therapy will be altered if the fragment is left, especially with the presence of periapical pathosis.^[2,29] In contrast, Crump and Natkin^[3] reported no effect. In general, bypassing or leaving the fragment without total removal might be considered as part of the root canal filling. The status of the root canal in the presence of the fragment will play an important role in the outcome of the therapy.

CONCLUSIONS

Regardless of little experience of the endodontic residents, they were successfully managed to remove or bypass most of the separated instruments. The endodontic instrument is usually separated in the apical third of the mesiobuccal root canal of molar teeth. Ultrasonic device was very helpful in removing the separated instrument. Care should be taken when dealing with instrument fragment in a curved canal to avoid procedural mishap.

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Conflicts of interest

There are no conflicts of interest.

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