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DATA ANALYSIS ON INSTRUMENT SEPARATION DURING ENDODONTIC TREATMENT AND ITS MANAGEMENT - A RETROSPECTIVE STUDY

Running Title: Instrument separation cases and its management
Type of Study: A retrospective study

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Abstract:*Separation of endodontic instruments within the root canal is an unfortunate event. A separated instrument prevents complete debridement and sealing of the root canal system. Hence, every attempt must be made to retrieve the broken instrument. When instrument separation happens, it leaves the clinician in despair, anxiety and atlast with a hope that non-surgical retreatment techniques would help in the removal of the instrument from the canal. The aim of this study was to analyse the different methods used for the management of retrieval of broken instruments. This retrospective study was entirely based on data abstraction from existing records available at Saveetha Dental College, Chennai. Record of 95 patients were reviewed and analysed. Out of these 14 patients who did not report for the follow up visits. Those were excluded from the study. A total of 81 cases were taken based on the inclusion and exclusion criteria. Out of which, 71% of cases were managed by obturating at the level of fracture, 22% cases were retrieved and 18% of cases the instrument was bypassed. In this study, seven different parameters were checked like the age, gender, sex, teeth type, type of instrument, site and location of the instrument. Within the limitation of this study, it can be concluded that, most of the cases were managed by obturating at the site of fracture, followed by bypassing technique, later by retrieval using ultrasonics, manual methods like forceps, and braided H file technique.*

Keywords*: Instrument separation, Hand file, Rotary files, Retrieval, Bypassing*

1. INTRODUCTION

Instrument fracture in endodontics is often an unpredictable and problematic occurrence that can prevent adequate root canal cleaning and shaping and adversely affect the prognosis of endodontic treatment.(Strindberg and LZ, 1956; Walton and Torabinejad, 2002) There are many factors which can contribute to the instrument fracture like tooth, separated instrument, operator and patient. (Bahcallet al., 2005; Di Fiore, 2007; Madarati, Watts and Qualtrough, 2008a; Ramamoorthi, Nivedhitha and Divyanand, 2015; Rajakeerthi and Ms, 2019; Siddique et al., 2019; Rahimi and Parashos, 2009) Most of the stainless steel instruments fail due to excessive torque and Niti rotary files usually fracture because of

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torsional stress and cyclic loading. Although Niti instruments are said to be more flexible, the advent of Niti alloys has not resulted in a lower incidence of instrument fracture (Tzanetakiset al., 2008) and the separation rate of stainless steel has been reported to range between 0.25% and 6%. (Tzanetakiset al., 2008) Even in experienced hands, this problem occurs and frustate both the clinician and the patient.

The success rates may vary according to devices, techniques, methods, and protocols used for removal of separated instruments. Masserman kit is one of the many methods for removal of the fractured fragment. Before a clinician makes the decision to remove a separated fragment, they should ensure the availability of and successful manipulation of the required materials, instruments and devices. Each individual case has its own unique characteristics that will dictate the approach taken to manage the case. However, a clinician infrequently might be fortunate to remove the separated instrument simply in the process of trying to bypass it, dislodging it coronally with other hand files, or even by irrigating the root canal. On the other hand, a loose fragment may be resistant to removal even after using several methods and devices. During the past several decades many devices, techniques, and methods have been described for removal of separated instruments. Although some are still widely used, others are only of historical interest. So, the aim of this study was to analyse the different methods used for the management of retrieval of broken instruments.

2. MATERIALS AND METHOD

Study Design

Single centered retrospective study

Ethical Approval

Approval for the project was obtained from the Institutional Review Board of Saveetha Institute of Medical and Technical Sciences, Chennai, India on date 18/04/2020.

3. Eligibility Criteria

Inclusion criteria

Inclusion criteria were cases which reported for the management of retrieval of the separated instruments at all levels in permanent teeth.

Exclusion criteria

Teeth with symptomatic irreversible pulpitis, teeth with preoperative pain, necrotic pulp with clinical symptoms such as swelling or purulence. Patients who were being treated with antibiotics were also excluded from the present study.

Data Extraction

This retrospective study was entirely based on data collected from the existing records available at Saveetha Dental College, Chennai from the year April 2019 to March 2020. Record of 95 patients were reviewed and analysed. Out of which 81 cases were selected after considering the inclusion and exclusion criteria. Cases of separated endodontic instruments retained in the root canal were evaluated based on different parameters like age, gender, tooth type, type of fractured instrument, site, anatomic location and method of its management (retrieved, bypassed or left inside the root canal and obturation done at the level of fracture). All case records were evaluated by the same examiner.

Sample Size

This retrospective study was entirely based on data collected from the existing records available at Saveetha Dental College, Chennai. Record of 95 patients were reviewed and analysed. There were 14 patients who did not report for the follow up visits. Those were excluded from the study. A total of 81 cases were taken for the study based on the inclusion and exclusion criteria.

Groups

The total sample was broadly divided into three groups based on the method which was used for the management of instrument separation

Group A: Retrieved

Group B: Bypassed

Group C: Obturated at the level of fracture

Clinical Outcome

There are various methods of the management of instrument separation like retrieval methods which includes manual, ultrasonics, mechanical techniques using various kits like Meitrac endo safety kit, Masserman kit, bypassing the fractured instrument and lastly obturation at the level of fracture.

Clinical Protocol

When patient reports for the management of instrument fracture, accurate diagnosis should be done with the help of clinical and radiographic findings. All the factors that are going to influence the removal like the level at which instrument is fractured, anatomical location, tooth type, root dentin thickness etc should be assessed. Based on all these findings, the method for management is decided.

Study Outcome

In this study, the maximum number of cases were managed by obturating at the level of fracture, followed by the bypassing method. Only in a few cases retrieval was attempted using ultrasonics, manual, mechanical methods and other techniques.

4. Statistical Analysis

Chi square test was done to assess these parameters. The outcome data was represented in the form of tables and graphs. The tables represent the distribution of frequency among age, gender, teeth number, method of retrieval, site of fracture, anatomical location and type of instrument. The graphs represent the correlation between these parameters - correlation of age and teeth type, gender and teeth type, Correlation between method and teeth type. After grouping of parameters, data was copied to SPSS software. The statistical analysis between all the groups was carried out in SPSS software. Chi square test was done to compare and check the association between different parameters.

Patients Characteristics	Number of Patients	Percentage
Gender		
Male	50	52.1
Female	45	46.9
Age		
10-20	5	5.2
21-30	18	18.8
31-40	36	37.5

41-50	18	18.8
51-60	14	14.6
61-70	4	4.2

Table 1: Showing distribution of cases which were included for the study based on Age, Gender. Maximum number of cases were reported in the age group of 31 - 40 years. Out of 95 cases, 52.1% were male and 46.9% were female.

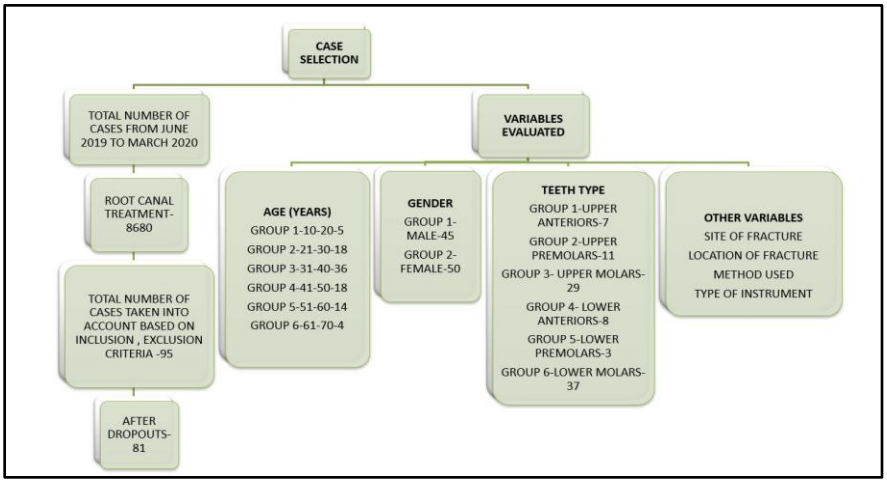
Tooth Distribution	Number of Teeth	Percentage
Jaw		
Maxillary	47	49
Mandibular	48	50
Teeth Type		
Anterior	15	15
Posterior	80	84
Teeth Number		
Central incisor	2	2
Lateral incisor	2	2
Canine	11	11
Premolars	14	14.7
Molars	66	69.4

Table 2: Showing distribution of cases which were included for the study based on teeth type. Out of 95 cases, 69.4% were molars, 14.7% were premolars, 11% were canine, and 4% were incisors

Age group	Frequency	Percent	Valid percent	Cumulative percent
10-20	5	5.2	5.3	5.3
21-30	18	18.8	18.9	24.2
31-40	36	37.5	37.9	62.1
41-50	18	18.8	18.9	81.1
51-60	14	14.6	14.7	95.8
61-70	4	4.2	4.2	100
Gender	**Frequency**	**Percent**	**Valid percent**	**Cumulative percent**
Female	50	52.1	52.6	52.6
Male	45	46.9	47.4	100

Teeth number	Frequency	Percent	Valid Percent	Cumulative percent
Upper anteriors	7	7.3	7.4	7.4
Upper premolars	11	11.5	11.6	18.9
Upper molars	29	30.2	30.5	49.5
Lower anteriors	8	8.3	8.4	57.9
Lower premolars	3	3.1	3.2	61.1
Lower molars	37	38.5	38.9	100
Type of procedure	**Frequency**	**Percent**	**Valid Percent**	**Cumulative percent**
Ultrasonics	6	6.3	6.5	6.5
Mechanical	4	4.2	4.3	10.8
Manual	4	4.2	4.3	15.1
Bypassed	15	15.6	16.1	31.2
Obturated	62	64.6	86.7	97.8
Others	2	21	2.2	100
Site of fracture	**Frequency**	**Percent**	**Valid Percent**	**Cumulative percent**
Coronal third	8	8.3	8.4	8.4
Middle third	40	41.7	42.1	50.5
Apical third	45	46.9	47.4	97.9
Beyond the apex	2	2.1	2.1	100
Anatomical location	**Frequency**	**Percent**	**Valid percent**	**Cumulative percent**
Single rooted	19	19.8	20.0	20.0
Mesiobuccal	30	31.3	31.6	51.6
Distobuccal	9	9.4	9.5	61.1
Mesiolingual	20	20.8	21.1	82.1
Distolingual	4	4.2	4.2	86.3
Palatal root of upper molars	12	12.5	12.6	98.9
Buccal or palatal root of Upper premolar	1	1.0	1.1	100
Type of instrument	**Frequency**	**Percent**	**Valid percent**	**Cumulative percent**
Rotary file	31	32.3	32.6	32.6
H file	4	4.2	4.2	36.8
K file	25	26.0	26.3	63.2
Others	35	36.5	36.8	100

Table 3: Showing distribution of cases based on age, gender, teeth number, method, site of fracture, anatomical location and type of instrument



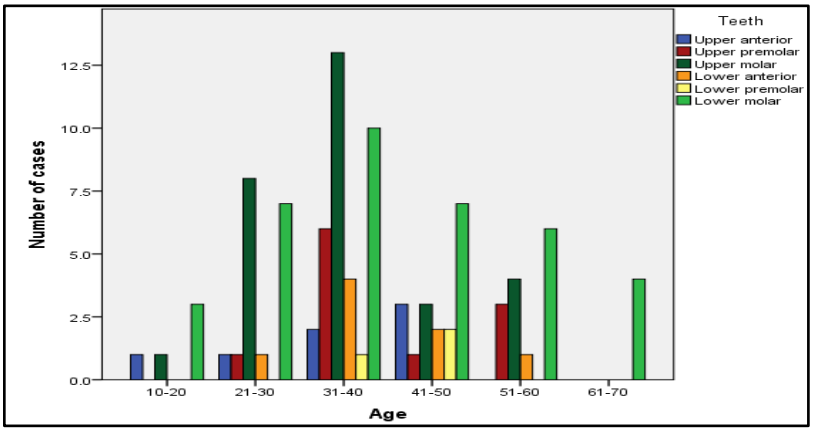
Flowchart 1: Selection of Cases in the Study

5. RESULTS AND DISCUSSION

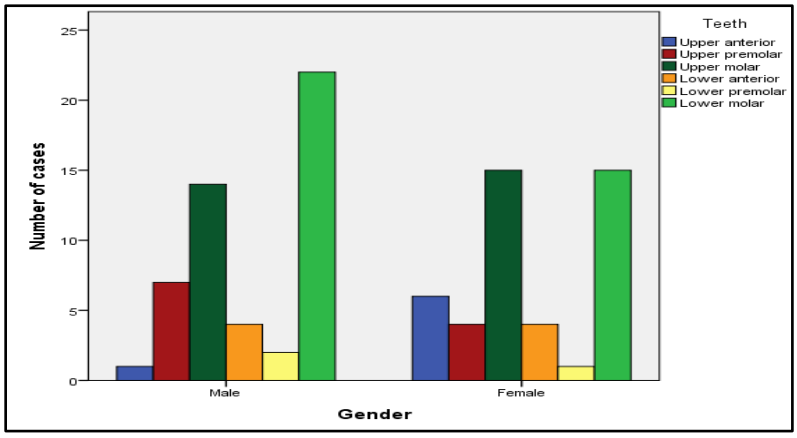
In this study, various methods were used for the management of instrument separation. A total of 81 cases had been reported for the management of instrument separation. Out of which, 71% of cases were managed by obturating at the level of fracture, 22% cases were retrieved and in 18% of cases instrument was bypassed. In this study, seven different parameters were checked like the age, gender, sex, teeth type, type of instrument, site and location.

Maximum number of cases reported were in the age group of 31-40 years (37%), minimum number of cases reported in 61-70 years age group (4.2%). Highest number of cases reported were female (52%) and the minimum number of cases reported were male (46.9%) . The molars were the maximum (69.4%) and incisors being the minimum (2%). Greater number of instrument fractures were found in mesiobuccal root (31.3%) and less in distolingual root of lower molars (4.2%). Cases reported more with in apical region (46.9%) and less beyond the apex (2%).(Table 3)

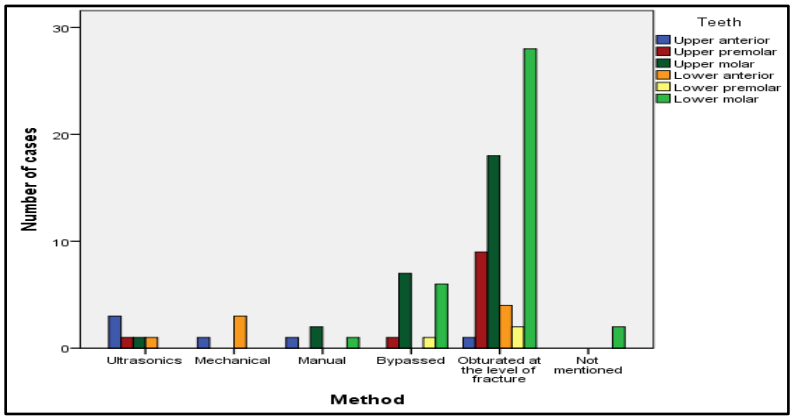
When the correlation between the age and teeth type, gender and teeth type were checked, the difference between the groups was not statistically significant with a P> 0.05(Graph 1, Graph 2). Correlation between the method and teeth type was statistically significant with a P <0.05. (Graph 3)



Graph 1: Bar chart showing association between age and teeth type, X axis represents the age group of the patient and Y axis represents the number of cases; Majority of the cases in the 31-40 years age group reported for instrument separation management in upper molar teeth (Dark green). Chi square test (24.919) was done and association was found to be not statistically significant. Pearson's Chi square P value - 0.467>0.05.



Graph 2: Bar chart showing association between gender and teeth, X axis represents the gender of the patient and Y axis represents the number of cases; Majority of the male cases reported for instrument separation management in lower molar teeth (Light green). Chi square test (5.835) was done and association was found to be not statistically significant. Pearson's Chi square value P value - 0.323>0.05.



Graph 3: Bar chart showing association between method and teeth, X axis represents the methods for instrument management and Y axis represents the number of cases. Majority of the lower molar (Light green) cases with separated instrument were managed by obturating at the level of separation. Chi square test (61.982) was done and association was found to be statistically significant. Pearson's Chi square P value - 0.000 <0.05.

When the instrument separates in the root canal system, two main concerns need to be addressed to increase the long-termoutcome. The first is the exit of the metal fragment in the tooth and prevention of corrosion. One report by Eleazer et al had concluded that the stainless-steel fragments did not exhibit corrosion after 2 years. (Eleazer, 1991)

Strindberg et al (Strindberg and LZ, 1956; Walton and Torabinejad, 2002) reported a 19% reduction in the rate of healing of apical tissue when separated instruments were present, compared with control cases without any separated instruments. Another study by Fox et al(Fox et al., 1972), revised 66 cases with an average follow up of 2 years. A favourable outcome was found in teeth with vital and necrotic pulp without periapical lesion. In contrast, when a periapical

lesion was present at the time of instrument separation the success rate reduced to 47%. So, it was concluded that a separated instrument affected the outcome only when a periapical lesion was present. (Teja, Ramesh and Priya, 2018; Janani, Palanivelu and Sandhya, 2020; Jose, P. and Subbaiyan, 2020)

In contrast, some studies reported no effect of retained separated instruments on the treatment outcome. Ingle et al, 1994, reviewed 1229 endodontic therapy cases for an average time period of 2 years. Only one of 104 failed cases involved a separated instrument. Similar results have been obtained in a study done by Crystal et al, 1970. Out of the 8500 cases, 178 cases were found with separate instruments. There was no significant difference in success rate between the separated instrument group and control group. Another study checked the influence of retained separated instruments including Niti rotary instruments on the prognosis of root canal treatment. (Manohar and Sharma, 2018; Nandakumar and Nasim, 2018; Teja and Ramesh, 2019)Spilli et al, 2005, out of 8460 cases, 146 teeth with retained fractured instruments were matched and compared with 146 controls. Overall success rates were reported to be 92% for the separated instrument group and 95% for the control group. (Spili, Parashos and Messer, 2005)

Another Meta analyses study concluded that the prognosis of root canal treatment when a separated instrument was left within a root canal, success rate was not reduced significantly. (Panitvisaiet al., 2010) However, other authors like Murray et, 2011 commented on that meta-analysis and highlighted that the sample numbers were not based on power calculation.(Murad and Murray, 2011)

Instrument separation in a root canal is influenced by many factors like tooth, operator experience, and type of instrument. Tooth factors mainly include anatomic factors like type of teeth, site, root diameter, and the degree of root curvature influencing the instrument separation.

Removal of the instrument is more predictable in maxillary teeth (Hülsmann and Schinkel, 1999; Shen, Peng and Cheung, 2004; Ramanathan and Solete, 2015; Hussainyet al., 2018; Rajendran et al., 2019), Anterior teeth, Fragment from the coronal third and in slightly curved or straight canals.(Ward, Parashos and Messer, 2003; Cujé, Bargholz and Hülsmann, 2010) The influence of anatomic factors can be explained in terms of visibility and access to fractured segments to manipulate and retrieve the fractured instrument safely. Moreover, removal of instruments is more predictable when there is a gap between the fragment and root canal.(Nagai et al., 1986; Noor and Others, 2016; Kumar and Antony, 2018; Ravinthar and Others, 2018). The next main factor which needs to be considered is the material and design of the fractured instrument. Niti instruments are more difficult to remove compared to stainless steel instruments for the following reasons, (Madarati, Watts and Qualtrough, 2008b)Niti tends to thread to the canal walls; they have greater tendencies to fracture repeatedly particularly when ultarsonics are used. They usually remain against the walls not in the centre. They fracture in shorter lengths making its retrieval difficult. It is also said that removal of K files is easier than Hedstroem files since they have helix angle degree flutes and greater positive rake angle. (Subrata and Hardini, 2019)

Separation of instruments may provoke clinicians to remove the fragment. However, one of the most important points for managing such cases is to adopt a methodological approach with patience. There are various methods for the removal of fractured segments but these are also associated with complications like ledge formation, perforation etc. So another approach for the management of separated instruments is not to retrieve but to preserve the integrity of the remaining tooth structure by bypassing the fractured instrument. Bypassing has been considered as a successful approach. But this should be carried out under high magnification to avoid complication like false channels parallel to the original canal(Xi, 2004).

6. CONCLUSION

Within the limitation of this study, it can be concluded that most of the cases were managed by obturating at the site of fracture, bypassing followed by retrieval using ultrasonics, manual methods which includes retrieval with forceps, braided H file technique. Bypassing is found to be the most successful approach. But it was not followed by many clinicians. This could probably be due to the necessity of high-level magnification and frequent radiographic checking and the fear of complications. However, cases with separated instruments should be recalled for the regular clinical and radiographic examination.

Declaration of Patient Consent

All authors certify that appropriate patient consent forms were obtained. The patients understand that their names and initials will not get published and their identity will be concealed.

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Nil

Overall Consensus

In agreement with the findings of the study.

Study Limitation and Future Scope

Limitation of the study includes limited sample size due to increased dropouts. Further study is required to identify other factors such as complexity in the root canal, design of instrument, material of the instrument etc. Randomized controlled trials are considered most reliable to establish the relationship between the contributing factors.

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