

ASSOCIATION BETWEEN THE QUALITY AND LENGTH OF THE OBTURATION AND ROOT CANAL FAILURE: AN INSTITUTIONAL STUDY

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ABSTRACT

Quality of obturation is one of the factors that influences the outcome of endodontic treatment. Thus the present study was conducted with the aim to determine the influence of length and quality of obturation on the failure of endodontic treatment. For the purpose of data collection, the preoperative radiographs of failed endodontic cases reported to the institute between June 2019 and April 2020 were analysed. Data was tabulated in excel sheet as poorly filled canals, obturations short of apex, obturations extending beyond the apex and adequate obturation. Further, the teeth were grouped into six categories as maxillary anterior, premolar and molars and mandibular anterior, premolar and molars. A descriptive statistical analysis and chi square test was performed. The results were represented in the form of tabulation and bar graphs. Of the 225 cases that matched the inclusion criteria, maximum endodontic failures were seen in maxillary anteriors (41.8%) followed by mandibular molars (25.8%) and maxillary molars (13.3%). Of these endodontic failure cases, 144 were due to poor and incomplete obturations (64%) 58 obturations were homogenous but short of the apex (25.8%). Only 15 cases were reported with over obturation (6.7%) and 8 radiographs depicted adequately obturated teeth undergoing endodontic failure (3.6%). Poorly filled canals were the primary reason that contributed to the majority of endodontic failures.

KEY WORDS: Endodontic Failure; Incomplete Obturations; Overfilled Obturation

INTRODUCTION

One of the factors that affects the success or outcome of an endodontic treatment is the quality and the length to which the obturation extends (Ricucci and Ricucci, 2002). The optimum length of the root canal obturation is still a controversial topic (Coolidge, 1929). However, prognosis is poorer when there is a significant overfill or underfill (Moura *et al.*, 2009). Kuttler believed that when the apical constriction exists, the obturation must terminate at the apical constriction (Kuttler, 2010).

Seltzer *et al.* states that the tissue reaction is more when apex is violated due to instrumenting beyond the apex as compared to instrumenting short of the apex (Seltzer *et al.*, 2004). Seltzer *et al.* also stated that there is a chronic inflammatory response when materials are extruded. ('Biologic aspects of endodontics: IV. Periapical tissue reactions to root-filled teeth whose canals had been instrumented short of their

apices', 1969) Studies have shown that failure of endodontic treatment occurs due to the presence of bacteria and necrotic tissue in unprepared areas of the root canal system (Siqueira *et al.*, 1997). Insufficient cleaning and inadequate sealing is the most common cause of endodontic treatment failure (Siqueira, 2001). Coronal restoration also has an impact on the success of an endodontic treatment (Gordon and Chandler, 2004). A well prepared canal which is well obturated may fail if the coronal restoration is poor (Mandke, 2016).

Radiographic assessment of the quality of root canal fillings is used as the basis to lay down criteria to define characteristics of density [the extent to which the root filling material uniformly and completely fills the canals] and extension [the distance from the end of the root filling material to the radiographic apex].

It is however not necessary that root fillings considered as inadequate by these criteria fail nor is it necessary that fillings that are deemed adequate under these criteria are an endodontic success. However, many studies have suggested that postoperative apical periodontitis are associated with poorly filled canals and extensions (Kirkevan *et al.*, 2000).

The present study was carried out with the aim of assessing failure of root canal associated with the quality of obturation.

AIM AND OBJECTIVES

The aim of the study was to evaluate the failure of endodontic treatment associated with the quality of obturation

The following were the objectives of the study:

1. Evaluate the number of endodontic failure cases reported with obturations short of the apex
2. Evaluate the number of endodontic failure cases reported with obturations beyond the apex
3. Evaluate the number of endodontic failure cases reported with adequately obturated canals
4. Evaluate the number of endodontic failure cases reported with incomplete and poor obturations
5. To analyse if there is any association between the type of tooth reported as an endodontic failure and the quality of obturation

MATERIALS AND METHOD

The study was carried out in the department of conservative dentistry and endodontics, after obtaining approval from the Institutional Ethics Committee (Ethical approval number: SDC/SIHEC/2020/DIASDATA/0619-0320). For the purpose of data collection, all the preoperative radiographs of cases reporting for retreatment were obtained from the database of the institute between June 2019 and April 2020.

The inclusion criteria was set to divide the failed endodontic cases into the following four groups based on the radiographic assessment of the quality and length of obturation:

1. Group A: Incomplete, non homogeneous obturations with voids and radiolucencies
2. Group B: Homogeneously obturated canals that are short of the apex (<2mm)
3. Group C: Homogenous obturations extending beyond apex
4. Group D: Adequately obturated canals

The exclusion criteria included the following endodontically failed cases

1. Perforations
2. Root fractures
3. Fractured instrument
4. Presence of post
5. Unobtured teeth
6. Cases that can be categorised into more than one group simultaneously
7. The teeth were grouped into six categories:
 1. Maxillary Anterior

2. Maxillary Premolar
3. Maxillary Molar
4. Mandibular Molar
5. Mandibular Premolar
6. Mandibular Anterior

The case sheets were evaluated by two reviewers and they were assigned to either of the four groups. M.S Office excel sheet was used to tabulate the collected data. Descriptive statistics in the form of frequency and percentage was calculated using the Statistical Package for Social Science V 2.0 (SPSS). A chi square analysis was done to analyse if there is any association between the type of endodontically failed tooth and the quality and length of obturation and also the failed endodontic cases with gender.

The results were represented in the form of tables and graphs.

RESULTS AND DISCUSSION

A total of 308 pre operative radiographs of the cases reporting for retreatment were evaluated out of which 225 matched the inclusion criteria. Maximum endodontic failures were seen in maxillary anteriors (41.8%) followed by mandibular molars (25.8%) and maxillary molars (13.3%). Of these endodontic failure cases, 144 were due to poor and incomplete obturations (64%) which were mainly observed in maxillary anterior teeth followed by mandibular molars; 58 obturations were homogenous but short of the apex (25.8%) which were mainly observed in maxillary molars. Only 15 cases were reported with over obturation (6.7%) and 8 radiographs depicted adequately obturated teeth undergoing endodontic failure (3.6%). (Table 1, Fig 1, Fig 2) The p value of the chi square test was <0.001 which indicates that the results obtained for incomplete obturations, obturations short of apex, obturations beyond apex and adequate obturations are statistically significant from each other (Table 2). While studying the association of failed endodontic cases with gender it was observed that there were a total of 148 males and 77 females. Of the total 144 incomplete obturations, 93 were observed in males and 51 were observed in females. Of the total 58 short obturations, 40 were males and 18 were females. Of the total 15 over obturated cases, 10 were males and 5 were females. Of the total 8 adequately obturated failed endodontic cases 5 were males and 3 were females. The chi square test gave a p value of 0.941 which was >0.05 and hence the results were not statistically significant (Fig 3).

Based on the observations made from the radiographic assessment of the quality of obturation in endodontic failures, the study reports that majority of the failures were due to the incomplete and poor obturations which had voids, followed by obturations that were short of the apex while only 6.7% of the cases were due to material extruding beyond the apex. Failure in the treatment was also seen in cases where the canals were well obturated with obturation ending between 0-2mm of the apex. However, the percentage of such failures were low (3.6%).

There was also an association seen between the type of tooth and the quality and length of obturation. The major reasons for the failure of endodontic treatment in maxillary anterior teeth was incomplete obturations with voids. One of the reasons for this could be the cross section of the canal. Maxillary anterior teeth have large oval canals (Barker *et al.*, 1973; 'Morphometric observations on root canals of human anterior teeth', 1977). A clinician must be skilled enough to render a perfect obturation while using the lateral condensation technique ('Filling Root Canals in Three Dimensions', 2006). Similarly, voids in the obturations were observed in 37 mandibular molars. This could be due to inadequate enlargement of the narrow and curved canals seen in mandibular molars which eventually leads to defects in the obturation (Barker, Parsons, *et al.*, 1974; Cunningham and Steve Senia, 1992; Ansari and Maria, 2012). Majority of the obturations that were short of the apex were seen in maxillary molars (Barker, Parsons, *et al.*, 1974) followed by mandibular molars. This could be due to the inability of the clinician to reach the complete working length either due to improper canal negotiation or due to improper techniques of

determining the working length or due to inaccessibility to the canals due to the position of the tooth, mouth opening or improper access cavity preparations.

Previously our team had conducted numerous clinical trials (Ramamoorthi, Nivedhitha and Divyanand, 2015; Nasimet *al.*, 2018; Janani, Palanivelu and Sandhya, 2020), in vitro studies (Ramanathan and Solete, 2015; Nandakumar and Nasim, 2018; Teja, Ramesh and Priya, 2018; Rajendranet *al.*, 2019) and surveyed (Manohar and Sharma, 2018; Jose, P. and Subbaiyan, 2020) and reviewed (Teja, K.V. and Ramesh, S., 2019; Noor, S Syed Shihaab and Pradeep, 2016; Kumar and Delphine Priscilla Antony, 2018; Ravinthar and Jayalakshmi, 2018; R, Rajakeerthi and Ms, 2019) various aspects of endodontics and conservative dentistry over the past five years. Now we are focusing on retrospective studies, the idea for which has stemmed from the current interest in our community. This retrospective study was conducted acknowledging the importance of a well obturated canal in three dimensions as a contributing factor the outcome of endodontic therapy.

Of foremost importance in the success of any treatment is diagnosis. Further, the success of an endodontic treatment relies on the adequate elimination of microorganisms and debris from all the canals and prevention of recolonization of residual micro organisms that can be achieved by placement of a well extended, homogeneously dense root canal filling that provides a hermetic seal followed by a coronal restoration that is biologically, functionally and aesthetically sound (Soikkonen, 1995). The treatment of failed root canal cases caused due to inadequate obturation demands the understanding of the bacterial etiology as well as the appropriate use of intracanal medications.

In the present study, the most common cause of failure was incomplete obturations with voids followed by obturations that were short of the apex. Similar results were obtained in a study conducted by Khan et al who stated that 40% of the endodontic failures were due to poorly filled canals, 34.7% cases were due to underfilled canals and 17.3% were canals which had no obturations. The lowest failures were due to overfilled obturation which was 5.3% which is in accordance to the present study (Khan et al., 2010).

The residual spaces due to inadequate preparation and filling of the root canal system, harbour microorganisms and necrotic debris which ultimately cause failure (Noor at al., 2008). According to a study by Cohen and Burns, 80,000 streptococci bacterial strains are present in 1mm of the canal with a diameter of 0.25mm (Cohen and Hargreaves, 2006).

Literature shows that the chances of endodontic failure increases by 14% in teeth with apical periodontitis with a 1mm loss in working length (Chugal Nm Clive Jm, 2003).

One of the reasons for poorly filled canals can be lack of adequate preclinical and clinical experience at the undergraduate level that eventually leads to lack of quality observed in general dental practice. A study conducted by Moradi et al has stated that the quality of obturation performed by undergraduate students to be less than ideal (Moradi and Gharechahi, 2014).

Although it is agreed that radiographic technical quality of the root canal failure influences the outcome there are other confounding factors involved such as irrigation, debridement and adequate coronal restoration. These factors could not be addressed due to the limitation of the present study but they definitely play a major role in the success and failure of an endodontic treatment.

Over extension of the obturating material usually indicates a faulty technique adopted for biomechanical preparation of the canal. Literature states that as long as an inferior alveolar nerve or sinuses and the apical terminus is filled in three dimensions, permanent harm is potentially small unless the obturating material contains paraformaldehyde (Gluskin, 2005). Further, periapical damage is also caused by the precipitate formed during irrigation due to components of chlorhexidine (Siddiqueet *al.*, 2019). Over instrumentation and violation of the apex is the cause for over obturation. Stein and Corcoran have reported that the position of tile placed for working length determination appears radiographically 0.7 mm shorter than its actual position. There is no guarantee that instrumentation beyond the apical foramen can be avoided by a working length that ends 0.2mm short of apex in molars and premolars (Stein and Corcoran, 1992). In a

recent meta analysis it was observed that obturating materials extruding beyond the radiographic apex correlated with a decreased prognosis for repair (Schaeffer, White and Walton, 2005).

In a retrospective study that evaluated the level of apical obturation on the treatment outcome, a root canal filling was considered satisfactory if its apical level was 0-2mm short of radiographic apex (Sjögren *et al.*, 1990). Such well obturated canals had the highest success rate. Similarly the failure in well obturated canal in the present study was low. These failures could be attributed to other confounding factors as mentioned previously.

CONCLUSION

From the present study, it can be concluded that poorly filled canals contribute to the highest failure rate in endodontic treatment. Technology has allowed many recent advances in dentistry for the provision of high quality treatment. This highlights the importance of accurate determination of working length, instrumentation technique and irrigation protocols which are directly related to the cause for poor obturations. Thus the length and quality of obturation has a considerable influence on the outcome and success of endodontic treatment.

CONFLICT OF INTEREST: There is no conflict of interest.

AUTHORS CONTRIBUTION: All authors have contributed equally in bringing out this research work.

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	INCOMPLETE OBTURATION	OBTURATION SHORT OF APEX	OBTURATION BEYOND APEX	ADEQUATE OBTURATION	TOTAL
MAXILLARY ANTERIOR	73	10	8	3	94
MAXILLARY PREMOLAR	10	6	3	1	20
MAXILLARY MOLAR	10	20	0	0	30
MANDIBULAR MOLAR	37	16	3	2	58
MANDIBULAR PREMOLAR	9	2	0	1	12
MANDIBULAR ANTERIOR	5	4	1	1	11
TOTAL	144	58	15	8	225
PERCENTAGE	64%	25.8%	6.7%	3.6%	

TABLE 1: Distribution of endodontic failure cases based on quality and length of obturation: values and percentage. There were a total of 94 maxillary anteriors, 20 maxillary premolar, 30 maxillary molar, 58 mandibular molar, 12 mandibular premolar, 11 mandibular anteriors. A total 144 cases failed due to inadequate obturation, 58 due to short obturations, 15 due to obturations beyond apex and 8 were those cases with adequately obturated canals.

	TOOTH CATEGORY	OBTURATION QUALITY
Chi-Square	142.067 ^a	208.582 ^b
df	5	3
Asymp. Sig.	.000	.000

Table 2: Chi Square Test: The p value of the chi square test is <0.001 which indicates that the results obtained for incomplete obturations, obturations short of apex, obturations beyond apex and adequate obturations are statistically highly significant from each other. The main cause for failed root canal in maxillary anterior is inadequate obturation whereas for maxillary molar is short obturation and for mandibular molars is inadequate obturations followed by short obturations.

a:0 cells (0.0%) have expected frequencies less than 5. The minimum expected frequency is 37.5

b:0 cells (0.0%) have expected frequencies less than 5. The minimum expected frequency is 56.3

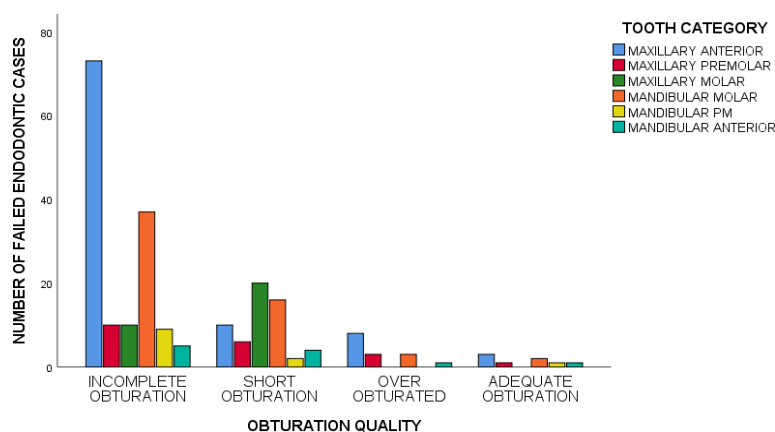


Figure 1: Graphical representation of distribution of endodontic failure cases based on quality and length of obturation among different tooth categories. X axis represents the quality and length of obturation and Y axis represents the number of failed endodontic cases. There were a total of 94 maxillary anteriors (blue), 20 maxillary premolar (red), 30 maxillary molar (dark green), 58 mandibular molar (orange), 12 mandibular premolar (yellow), 11 mandibular anteriors (light green). A total 144 cases failed due to inadequate obturation, 58 due to short obturations, 15 due to obturations beyond apex and 8 were those cases with adequately obturated canals. The p value of the chi square test is <0.001 which indicates that the results obtained for incomplete obturations, obturations short of apex, obturations beyond apex and adequate obturations are statistically highly significant from each other. The main cause for failed root canal in maxillary anterior is inadequate obturation whereas for maxillary molar is short obturation and for mandibular molars is inadequate obturations followed by short obturations, the p value for which is <0.001 which is statistically significant.

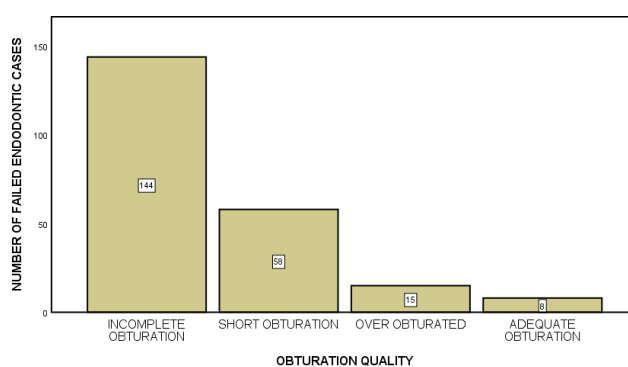


Figure 2: Distribution of failed endodontic cases based on quality and length of obturation. X axis represents the quality and length of obturation and Y axis represents the number of failed endodontic cases. 64% of the cases were due to incomplete obturation, 25.8% were due to short obturations, 6.7% were due to obturations extending beyond apex and 3.6% cases were those with adequate obturation. Maximum failed endodontics cases were due to incomplete obturations.

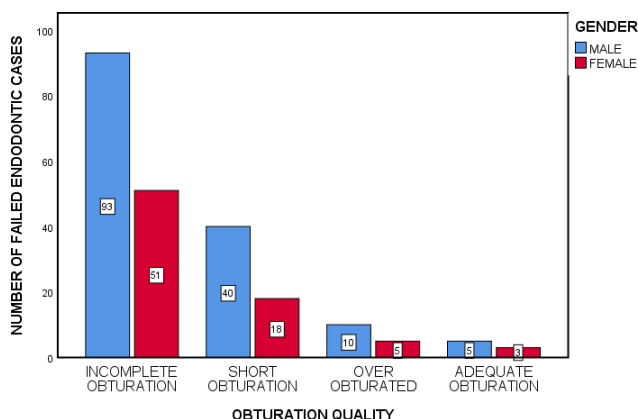


Figure 3: Distribution of failed endodontic cases based on gender. There were a total of 148 males (blue) and 77 females (red). Of the total 144 incomplete obturations, 93 were observed in males and 51 were observed in females. Of the total 58 short obturations, 40 were males and 18 were females. Of the total 15 over obturated cases, 10 were males and 5 were females. Of the total 8 adequately obturated failed endodontic cases 5 were males and 3 were females. The chi square test gave a p value of 0.941 which was >0.05 and hence the results were not statistically significant.