

Evaluation of Quality of Root Canal Obturation, Coronal Restoration and Periapical Health in Failed Endodontically Treated Teeth

Syed Adeel Ahmed, Safia Anwar, Imtiaz ul Haq

ABSTRACT

Objective: To investigate the implication of quality of obturation and coronal restoration on periapical tissue in failed endodontically treated teeth.

Study Design and Setting: This cross-sectional research was performed in the Operative Department of BUMDC on 187 patients reporting with root canal failure from March 2019 to August 2019.

Methodology: Patients of both genders aged between 20-60 years were considered for this study. Single and multirouted teeth indicated for repeated endodontic treatment due to under filled, overfilled obturation, voids in obturation, absence and presence of coronal restoration were included. One operator carried out clinical examination of the teeth and periapical radiograph was taken for each patient by using E-Speed film and evaluated by the same operator using an illuminated viewer box. SPSS 17 for windows software was used for data entering and chi-square test was applied for statistical calculation of the outcomes.

Results: Total n=187 endodontic treated failed teeth were evaluated, out of which 52.9% were of females and 47.1% to males. The number of obturations with acceptable length were 81(43.3%), with adequate density were 107 (57.2%) and with consistent taper were 116(62%). Periapical lesion was observed in 118(63.1%) cases. Quality of obturation significantly affects the periapical health. Cross tabulation showed a significant association (p -value <0.000) between inadequate coronal restoration and changes in periapical area.

Conclusion: The successful prognosis of the root canal treatment relies on the good quality of obturation and adequate coronal filling.

Keywords: Coronal restorations, Obturation, Radiographic assessment, Root canal treatment.

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INTRODUCTION:

The favorable outcome of endodontic treatment is dependent on complete debridement of the root canals, extirpation of affected pulpal tissues, microbes, and hermetic seal of the system to inhibit the reinfection of the root canals.¹ The literature reveals that various reasons are considered accountable for root canal treatment failure such as incomplete pulpectomy, fractured instruments, missed canals, perforation during canal preparation, overextended and underfilled obturation.^{2,3,4} The American Association of Endodontists (AAE), described a criteria

based on clinical and radiographic parameters for evaluating the technical success of obturations.⁵

Clinically, for a successful endodontic treatment, percussion, palpation, periodontal pocket depth, and comprehensive checkup of the final coronal restoration should show normal features during periodical follow-up visits. The length, shape and density of the obturation should be assessed radiographically.⁶ Current research has revealed a positive correlation between the condition of root canal treatment, the quality of definitive restoration and a patient's periapical condition.⁷ The excellence of quality of obturation is determined by various factors, such as consistent taper of the canal from orifice to apex, compact root canal filling without spaces, and obturating materials 0.5–2 mm short of the radiographic apex.^{7,8} So there is an increase in the failure rate by 14% after every subsequent loss of 1mm in length in teeth with associated apical periodontitis.⁹ Underfilled and overfilled obturations also jeopardize the success rate of root canal treatment.¹⁰ The condition of definitive coronal restoration also has an influence on the periapical tissue of teeth that have undergone root canal treatment.¹¹ The result of an underfilled root canal obturation can be satisfactory, if the definitive coronal restoration

Syed Adeel Ahmed
Senior Lecturer, Department of Operative Dentistry
Bahria University Medical and Dental College, Karachi
Email: dr.syedadeelahmed@gmail.com

Safia Anwar
FCPS Resident Operative Dentistry
Fatima Jinnah Dental College, Karachi

Imtiaz ul Haq
Lecturer, Department of Operative Dentistry
Bahria University Medical and Dental College, Karachi

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is qualitatively adequate.¹² Conversely a tooth having a cleaned and well obturated root canal system but with poor definitive restoration, may fail soon.¹³ Numerous observational researches revealed the incidence of insufficiently obturated root canals in relation to normal periapical tissue, and epidemiological statistics have shown various treatment consequences in different regions of the world, with prevalence's of inadequate root canal obturation of up to 72.4%, and with 87.0% of these teeth presenting apical periodontitis.^{14,15,16} Acceptable endodontic treatment according to the European Association of Endodontists displays a consistent taper in the canal from coronal to apical portion and densely filled with no voids between the obturating material and canal wall. To prevent post treatment failure, obturation should be no more than 0-2 mm short of the radiographic apex.¹⁷ Research has established that obturation more than 2 mm short of the radiographic apex, extruded past the apex and non-homogeneous with spaces between the fillings enhance the risk of root canal treatment failure.¹⁸ This study identifies the reasons, primarily accountable for the root canal failures, so highlighting the aspect that significant steps should be taken to enhance the contemporary dental practice in relation to quality of endodontic therapy. Therefore, the primary aim of this study was to assess the effect of quality of obturation and coronal restoration on the health of periapical tissue in failed root canal treated teeth.

METHODOLOGY:

This descriptive cross sectional study was carried out at the Endodontic Department of BUMDC after approval by the college ethical committee (ERC no. 014/2019). Sample size was estimated from openepi.com software. The conditions were 95% confidence interval, 5% margin of error. Population size was estimated to be 360 (secondary source of information collected from selected colleges) at a prevalence rate of 50%. The required sample size was drawn to be 187 patients. A total of 187 patients during the period from March 2019 to August 2019, reporting to the Endodontic Department of the College with root canal treatment failures were studied clinically and radiographically. Informed consent was taken from the patients. Patients of both genders, aged between 20-60 years, multirouted and single rooted tooth indicated for repeated endodontic treatment due to underfilled and overfilled obturation, voids in obturation, absence and presence of coronal restoration were included in the study. Patients having periodontally compromised teeth, third molar, non-restorable teeth, dilacerated teeth, teeth with perforations and canals with separated instruments were excluded. One operator carried out clinical examination of the teeth and soft tissues. And periapical radiograph was taken for each patient. All periapical radiographs were taken with an Endograph DC X-ray unit (Villa Sistemi Medicali S.p.A. Italy) using E-Speed film (Eastman Kodak)

using cone indicating devices to minimize distortion and processed with liquid fixer and developer according to the manufacturer's guidelines. The periapical radiographs were assessed by the same operator with an illuminated viewer box for variables such as quality of obturation and status of the apical tissue according to the guidelines provided by De Moor et al. and evaluation of coronal restorations was done by criteria recommended by Siqueira et al (Table 1). The data from radiograph was documented on a proforma specially designed for the study. Definition of all criteria is explained in proforma. To evaluate the procedural quality of root canal obturation on radiograph, three criteria were evaluated as monitors: Length of root canal filling, which includes three parameters: 1. Adequate: Obturating material is within the confines of the root canal system and no more than 2 mm of the radiographic apex; Under-filled: Obturating material is more than 2 mm short of the radiographic apex; Over-filled: Obturating material is extruding past the radiographic apex. 2. Compactness of obturating material which includes two parameters: the presence or absence of spaces within the root canal obturating material or between the root canal walls and obturating material. 3. Taper: Presence and absence of constant taper from the orifice of the root canal to the apex.

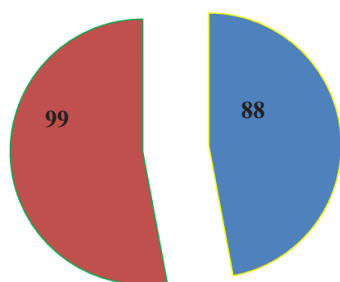
The technical quality of the obturation was considered adequate if the obturation terminated from 0-2 mm of the apex radiographically with no obvious voids within the obturating material or between the root canal walls and the material and steady taper from the coronal to the apical portion. In contrast, the technical quality of the obturations was considered insufficient when one or more of the aforementioned parameters were absent. Teeth with intact coronal restorations were considered acceptable. In teeth where coronal restorations were completely dislodged, partially fractured or had insufficient marginal seal were considered insufficient. SPSS 17 for windows software was used for data entering and statistical analysis. Chi-square test was applied to evaluate the influence of the quality of obturation, coronal restorations on the health of periapical tissue and *p* value < 0.05 was considered significant.

RESULT:

Total n=187 endodontically treated teeth were evaluated amongst which 47.1% belonged to men and 52.9% belonged to female. (Fig. 1) The mean age of the patients was 35.54 [S.D±9.087] years. Out of 187 Root canal failed teeth, 107 (57.2%) were present in mandibular and 80 (42.8%) belonged to maxillary arch. The most prevalent teeth were molars 78 (41.7%), followed by 64 (34.2%) premolars and 45 (24.1%) anteriors. (Table 2) The number of root canal obturations with acceptable length was 81 (43.3%), with acceptable density were 107 (57.2%), and with consistent taper were 116 (62%). Inadequate length of obturation was recorded in 106 (56.7%) of cases, while non-homogenous filling was noted in 80 (42.8%) teeth and inadequate taper

was observed in 71 (38%) cases. Periapical lesion was observed in 118 (63.1%) cases. Quality of obturation (length p-value 0.00, density p-value 0.00, and taper p-value 0.00) significantly affects the periapical health. (Table 3) Considering the type of tooth, the majority of the endodontic failures were observed in molars (n=46) 38.98% followed by premolars (n=43) 36.44%, while the anteriors (n=29) 24.58% showed the least endodontic failures. The condition of the coronal restoration was unacceptable in 74 (39.6%) cases, while in 113 (60.4%) cases coronal restorations had satisfactory quality. Cross tabulation between leakage from inadequate restoration and periapical alterations showed significant association with p-value 0.000 (Table 4). There was no significant difference ($p>0.05$) among the tooth-type (Anteriors, premolars and molars) and periapical lesion. There was also no significant association ($p>0.05$) between arch and periapical health.

Figure 1: The mean age of the patients



DISCUSSION:

It has been reported that there is a direct correlation between the quality of root canal filling, the result of root canal therapy and the health of periradicular tissues.^{19,20} The method using periapical radiographs constitute the most commonly employed method in the evaluation of endodontic treatments.²¹ If the endodontic treatment has not been done up to the adequate standards, the failure of endodontic management occurs. The key factors contributing to the failure of root endodontic treatment are the tenacious microorganisms in the root canal system and periradicular area. In the current study the most common factor attributing to the failure of endodontic treatment was inadequate length of the obturation (56.7%) in root canals.

Obturing material more than 2mm short of the radiographic apex usually occurs as the consequence of inadequate chemo-mechanical preparation, which usually arises as a result of erroneous working length calculation and insufficient irrigation of the root canal system, which consequently leads to endodontic failures.¹² It was observed by Chugal et al that shortening the working length by 1 mm increases the risk of root canal treatment failure by 14% in teeth with established apical periodontitis.⁹ Endodontic treatment failure is also related to tooth position in the arch. The present study reveals that the majority of root canal treatment failures occurred in the molars (41.7%). This probably owes to the fact that these teeth are comparatively difficult to access and have a complex root canal morphology.

The overall widely recognized description behind root canal

Table 1. Criteria for radiographic evaluation of the quality of root canal fillings

| | | |
|---------------------------------------|----------------|--|
| Quality of root canal fillings | Acceptable | Acceptable condensation and extent of root canal filling with no mishap |
| | Non-acceptable | Non-acceptable condensation and/or non- acceptable length of obturation with/without mishap |
| Length of the RCF | Acceptable | Obturing material confined within the root canal system and no more than 2 mm short of radiographic apex |
| | Non-acceptable | Obturation is more than 2 mm short of the radiographic apex |
| | Non-acceptable | Obturation material is not confined to the root canal system and extruding beyond the radiographic apex |
| Density of the RCF | Acceptable | Consistent root canal filling, good condensation, no visible voids |
| | Non-acceptable | Poor Non-homogeneous root canal filling, poor condensation or voids present |
| Taper of the RCF | Acceptable | Steady and uniform taper from the orifice to the apex of the canal, with reflection of the original shape of the canal |
| | Non-acceptable | Poor Inconsistent taper from the coronal to the apical part of the filling |
| Coronal restorations | Acceptable | Restoration present |
| | Non-acceptable | Restorations missed, partly fractured |

treatment failure in the multirooted teeth was untreated or unfilled canals followed by underfilling of the root canal system. The percentage of obturations with steady taper was 62%, which was lower than that reported by Balto et al²², Elemam et al²³, Roman-Richon et al.¹⁹ The percentage of satisfactory density of obturations in the current study was 57.2%, which was lower than that reported by Elemam et al²³ 2015, Kelbauskas et al²⁴, and Roman-Richon et al.¹⁹

The rates of acceptable density in these studies were 75.8%, 79.5%, and 69%, respectively. However, our result was higher than that reported by Balto et al²² and Moussa-Badran et al 2008.²⁵ In these studies, 34.9% and 42.7% of cases, respectively, had a dense root canal filling without voids. Radiographic evaluation of teeth showed obturations were satisfactory with respect to both length and consistency in 32.60% cases. In sixty-nine teeth assessed as improperly filled, 62 were related periapical infection. Inadequate coronal restorations compromise the coronal seal of the root canal fillings, which is as important, if not more, as the apical seal. A recent study mentioned that inadequate coronal restorations increase the occurrence of periapical lesion. This in accordance with the present findings.²⁶

Another study proved that with an odds ratio of 2.556, the health of periapical tissue with compact and accurate length of the obturation was more than twice if compared with poor quality of obturation ($p < 0.0001$).²⁷ A current meta-analysis proved an increased ratio of healing of periapical lesion with acceptable quality of both root canal therapy and coronal restoration, and poor clinical results in case of inadequate treatment and restoration.⁸ A recent study observed that 128 (6.2%) of the endodontically treated teeth showed acceptable consistency, satisfactory length of the root canal material, and concurrently acceptable coronal restoration, periapical lesion was found in 29.7% of these cases. On the other hand, the combination of inadequate endodontic obturation and poor coronal restoration did not result in periapical inflammation in every case.²⁸ Increase in laboratory training and adding of seminars would be beneficial for dentists to familiarize with necessary

Table 2. Distribution of teeth within Arch, tooth type, quality of obturation, periapical lesion and coronal restoration N=187

| | | N=187 | % |
|------------------------------------|-----------------|-------|------|
| Arch | Maxillary arch | 80 | 42.8 |
| | Mandibular arch | 107 | 57.2 |
| Tooth type | Anteriors | 45 | 24.1 |
| | Premolars | 64 | 34.2 |
| | Molars | 78 | 41.7 |
| Length of root canal failed tooth | Adequate | 81 | 43.3 |
| | Inadequate | 106 | 56.7 |
| Density of root canal failed tooth | Adequate | 107 | 57.2 |
| | Inadequate | 80 | 42.8 |
| Taper of root canal failed tooth | Adequate | 116 | 62.0 |
| | Inadequate | 71 | 38.0 |
| Periapical status | Adequate | 69 | 36.9 |
| | Inadequate | 118 | 63.1 |
| Coronal restoration | Adequate | 113 | 60.4 |
| | Inadequate | 74 | 39.6 |

Table 3: Crosstabulation between quality of obturation, coronal restorations and health of periapical tissue

| Quality of obturation | | Periapical lesion | | Total | P-value |
|-----------------------|--------------|-------------------|------------|------------|---------|
| | | Absent | Present | | |
| Length of RCF | Adequate | 58 | 23 | 81 | 0.000 |
| | Inadequate | 11 | 95 | 106 | |
| | Total | 69 | 118 | 187 | |
| Density of RCF | Adequate | 59 | 48 | 107 | 0.000 |
| | Inadequate | 10 | 70 | 80 | |
| | Total | 69 | 118 | 187 | |
| Taper of RCF | Adequate | 60 | 56 | 116 | 0.000 |
| | Inadequate | 09 | 62 | 71 | |
| | Total | 69 | 118 | 187 | |
| Coronal restorations | Adequate | 62 | 51 | 69 | 0.000 |
| | Inadequate | 07 | 67 | 118 | |
| | Total | 69 | 118 | 187 | |
| Arch | Maxillary | 37 | 43 | 80 | 0.032 |
| | Mandibular | 32 | 75 | 107 | |
| | Total | 69 | 118 | 187 | |
| Tooth type | Anteriors | 16 | 29 | 45 | 0.587 |
| | Premolars | 21 | 43 | 64 | |
| | Molars | 32 | 46 | 78 | |
| | Total | 69 | 118 | 187 | |

Table 4: Crosstabulation between quality of obturation and coronal restorations

| Quality of obturation | | Coronal restorations | | Total | P-value |
|-----------------------|--------------|----------------------|------------|------------|---------|
| | | Adequate | Inadequate | | |
| Length of RCF | Adequate | 67 | 14 | 81 | 0.000 |
| | Inadequate | 46 | 60 | 106 | |
| | Total | 113 | 74 | 187 | |
| Density of RCF | Adequate | 81 | 26 | 107 | 0.000 |
| | Inadequate | 32 | 48 | 80 | |
| | Total | 113 | 74 | 187 | |
| Taper of RCF | Adequate | 81 | 35 | 116 | 0.000 |
| | Inadequate | 32 | 39 | 71 | |
| | Total | 113 | 74 | 187 | |
| Arch | Adequate | 54 | 25 | 80 | 0.000 |
| | Inadequate | 58 | 49 | 107 | |
| | Total | 113 | 74 | 187 | |
| Tooth type | Anteriors | 22 | 23 | 45 | 0.147 |
| | Premolars | 41 | 23 | 64 | |
| | Molars | 50 | 28 | 78 | |
| | Total | 113 | 74 | 187 | |

procedures and precautions required for managing molars in root canal treatment. The use of dental magnification such as magnifying loupes and operating microscopes while performing molar endodontics would enhance visualization of the treatment field and increase accuracy of the endodontic procedure.

It is recommended that correct case selection is very necessary and should be ensured to increase the success of the endodontic therapy. Also teeth with complicated anatomy should be carefully assessed by new radiographic techniques and referred to the endodontists. The limitations of the study included that others causes associated with failure of root canal treatment were not evaluated and one radiographic technique was used to judge the procedural mistake.

CONCLUSION:

This study concludes that success of the endodontic therapy depends on the quality of the root canal fillings and good quality of coronal restoration. Molar teeth are more challenging to treat endodontically due to their complex anatomy with the lack of knowledge, the deficiency of specific instruments and lack of training of these instruments.

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Authors Contribution:

Syed Adeel Ahmed: Data Collection, discussion write-up
Safia Anwar: Writeup
Imtiaz ul Haq: Literature search

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