

The Outcomes of Root Canal Treatment Undertaken by Dental Students in Kulliyah of Dentistry, IUM: Periapical Health

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Abstract

The aim of this study is to determine the outcome of root canal treatment based on periapical healing. Two calibrated researchers assessed the clinical and radiographic presentations of 175 root canal treated teeth with at least 6 months recall period. Periapical status was determined with Periapical Index score and compared with the preoperative score. Univariate logistic regression was used to assess the association between prognostic factors (preoperative, intraoperative, and postoperative) with strict criteria and loose criteria. The success rate was 60% when using strict criteria and 99% when using loose criteria. Preoperative periapical status influenced the success where the cases with PAI score 1 and 2 significantly has higher success rate when compared with the cases with PAI ≥ 3 .

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Introduction

The outcome of primary root canal treatment has been reported in many studies. Some studies have highlighted success rates, determined as periapical healing¹⁻³ while others reported survival rates, determined as tooth retention.^{4,5}

The success rate (periapical healing) of primary root canal treatment was reported to range between 68% and 85% when assessed with strict criteria.² Strict criteria is defined as complete resolution of periapical lesion at follow up visit.² In another study, the reported success was 83% for 2 to 4 years observation period.³ A higher success rate was seen in teeth without apical periodontitis (92%) compared to the teeth with apical periodontitis (74%).¹ The outcome data from these studies vary significantly depending on multiple factors such as using strict or loose criteria for the assessment and presence or absence of periapical lesion prior to root canal treatment. Therefore, the results in outcome

studies should be interpreted with great caution.

Periapical Index (PAI) was introduced in order to assess the periapical status of the tooth radiographically.⁶ This index score ranged from 1 to 5, corresponding to a normal periapical status to severe periapical periodontitis respectively. The validity of the index was verified with the histological analysis of the periapical tissue. Utilizing plain radiograph for the assessment of periapical healing has various limitations⁷ and that does not represent the true nature of the tooth condition. Therefore, a new index based on cone beam computed tomography (CBCT) was introduced to overcome the limitations of plain radiography.^{8,9} High resolution image of CBCT improves diagnostic accuracy because of the representation of a true nature of the condition and as such improves the likelihood of proper management.^{10,11} However, CBCT has its limitations such as beam hardening and scattering effects from the neighboring metallic structure (e.g. amalgam restorations, metal posts and/or crowns, and implants) or even gutta-percha.^{9,11} If the structure to be analyzed is close to these images, the diagnostic value of the images is reduced.

Several prognostic indicators for the success of primary root canal treatment have been mentioned in previous report.³ These

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include the influence of preoperative, intraoperative and post-operative factors where in certain situations are impossible to control. However, it can be used as valuable information to help in informing the patients on the likely treatment outcomes, as well as possible treatment benefits and risks so that the clinicians and patients have a general understanding of the factors influencing the success treatment.

The aim of this study is to report the outcome of root canal treatment based on the periapical healing and to identify the factors that can influence the success.

Materials and methods

Ethical approval was obtained from the International Islamic University Malaysia (IIUM) Research Ethics Committee in order to get the access to the patients record (IREC 2018-039).

Sample selection

The study was conducted at the Kulliyah of Dentistry (KOD), IIUM from 11th July 2018 until 12th June 2019. A list of the potential patients was retrieved from the database and from student's clinical logbooks. Sample size calculation was done using Raosoft sample size calculator involving a total of 151 teeth.

The samples were selected according to the following criteria:

Inclusion criteria:

- i. Patients treated by undergraduate dental students.
- ii. At least 6-month review following the completion of root canal treatment.
- iii. Primary root canal treatment.

Exclusion criteria:

- i. Incomplete root canal treatment.
- ii. Periodontally involved teeth.

All included samples had root canal treatment done between 31st March 2015 and 28th March 2019. Potential patients were contacted by phone, invited for the follow up visits and scheduled for the appointments. Written consent was taken from all patients on the day of recall visit.

Calibration

A set of radiographs with a variety of periapical bone densities was retrieved from the database of patient records. Two researchers assessed the radiographs independently based

on the Periapical Index (PAI) developed by Orstavik (1986).⁶ Disagreements were resolved by discussion until a final decision was reached. A repetition of radiographic assessment was done after one month to determine the consistency of radiographic interpretation. Cohen Kappa value was recorded to assess inter and intra-observer reliability.

Periapical healing

Two researchers performed the clinical and radiographic examinations independently. All information was recorded in a data sheet for comparison against pre-operative records. The outcome of periapical healing was classified according to the previous report.³

Strict criteria: absence of pain, clinical evidence of inflammation or swelling and conventional radiographic measures of complete healing/presence of a normal periodontal ligament space.

Loose criteria: absence of pain, clinical evidence of inflammation or swelling and conventional radiographic measures of complete healing/presence of a normal periodontal ligament space or incomplete healing (reduction in size of the lesion without return to normal periodontal ligament space width).

Failed: Tooth that is extracted because of endodontic problems (persistent pain, swelling, sinus or periapical radiolucent lesion). Tooth extraction without any exit data on postoperative periapical status were excluded from data analysis.

Statistical analysis

Statistical analysis was performed using IBM SPSS version 25. Frequency and percentage were used in descriptive analysis for the strict, loose and failed criteria. Univariate logistic regression was used to assess the association between prognostic factors (preoperative, intraoperative, and postoperative) with strict criteria and loose criteria.

Results

The Cohen Kappa values for the inter-examiner reliability for sessions 1 and 2 were 1.0 and 0.7 respectively. Intra-examiner reliability for the examiners 1 and 2 was 0.7 and 0.8 for both sessions respectively. The calibration showed a substantial agreement between examiners.

A total of 196 teeth from 161 patients were treated in the undergraduate dental clinic.

Of these, 175 teeth from 143 patients fulfilled the inclusion criteria for further assessment. From the total of the teeth reviewed, 99% were asymptomatic and showed evidence of periapical healing, either complete or incomplete. When using strict criteria, 60% of the teeth were considered successfully treated. Meanwhile, about 39% of the teeth were asymptomatic and showed evidence of radiographic healing; reduction in size of apical lesion or sign of trabeculation. Only a small percentage of failure (1%) was found (Table 1).

Assessment criteria	Frequency	Percent	Valid percent	Cumulative percent
Strict	105	59.3	60.0	60.0
Loose	68	38.4	38.9	98.9
Failed	2	1.1	1.1	100.0
Total	175	98.9	100.0	

Table 1. Percentage of success following assessment criteria.

The frequency of healing is higher within 1-2 years of recall period. Almost half of the healed teeth were seen during this period. Complete healing was less frequent in cases reviewed less than a year (Table 2).

		Recall period				Total	
		6-12 months	1-2 year	2-3 year	3-4 year		
Success	Strict criteria	Count	21	46	32	6	105
		% within success	20.0%	43.8%	30.5%	5.7%	100.0%
	Loose criteria	Count	15	28	21	4	68
		% within success	22.1%	41.2%	30.9%	5.9%	100.0%
	Failed criteria	Count	0	1	1	0	2
		% within success	0.0%	50.0%	50.0%	0.0%	100.0%
Total		Count	36	75	54	10	175
		% within Success	20.6%	42.9%	30.9%	5.7%	100.0%

Table 2. Frequency of healing following recall period.

Preoperative periapical status had significant influence on the outcome of treatment. Cases with PAI ≥ 3 have lower success rates when compared against cases with PAI 1 and 2. Other preoperative factors including quality of restoration, tenderness to percussion or palpation, and presence of sinus tract or swelling did not have a significant impact on the success of treatment. Several intra and post-operative factors did not have any significant impact on outcome (Table 3).

Coronal Status	39	1		1	
Tooth coloured restoration	11	0.818 (0.211, 3.176)	0.772	1.222 (0.315, 4.744)	0.772
Amalgam restoration	26	1.851 (0.624, 5.488)	0.267	0.540 (0.182, 1.602)	0.267
Temporary	31	0.561 (0.214, 1.474)	0.241	1.375 (0.523, 3.601)	0.517
Caries	25	0.868 (0.311, 2.423)	0.787	1.152 (0.413, 3.218)	0.787
Defective restoration	2	-	-	-	-
Intact	1	-	-	-	-
Crown	1	-	-	-	-
Presence of sinus tract	127	1		1	
No	22	0.519 (0.208-1.295)	0.160	2.061 (0.826-5.143)	0.121
Yes	11	0.549 (0.160-1.888)	0.341	1.938 (0.563-6.673)	0.294
Presence of swelling	138	1		1	
No	11	0.549 (0.160-1.888)	0.341	1.938 (0.563-6.673)	0.294
Yes	11	0.549 (0.160-1.888)	0.341	1.938 (0.563-6.673)	0.294
Tenderness to palpation	128	1		1	
No	21	0.649 (0.252-1.672)	0.371	1.646 (0.638-4.243)	0.302
Yes	21	0.649 (0.252-1.672)	0.371	1.646 (0.638-4.243)	0.302
Tenderness to percussion	65	1		1	
No	84	0.748 (0.384-1.456)	0.393	1.360 (0.695-2.660)	0.369
Yes	84	0.748 (0.384-1.456)	0.393	1.360 (0.695-2.660)	0.369
Periodontal status	140	1		1	
No	9	0.675 (0.162-2.810)	0.589	1.574 (0.378-6.560)	0.533
Yes	9	0.675 (0.162-2.810)	0.589	1.574 (0.378-6.560)	0.533
Preoperative mobility	146	-		-	
No	2	-		-	
Yes	2	-		-	
Preoperative periapical status	47	1		1	
PAI 1	40	0.442 (0.162-1.208)	0.111	3.173 (1.077-9.343)	0.036
PAI 2	21	0.274 (0.086-0.865)	0.027	5.125 (1.518-17.306)	0.008
PAI 3	35	0.107 (0.038-0.300)	0.000	13.097 (4.338-39.344)	0.000
PAI 4	29	0.179 (0.063-0.511)	0.001	7.810 (2.555-23.871)	0.000
PAI 5	29	0.179 (0.063-0.511)	0.001	7.810 (2.555-23.871)	0.000
Intraoperative factor					
Position of root filling	163	1		1	
Radiographic apex	8	0.610 (0.147-2.529)	0.496	1.729 (0.417, 7.17)	0.451
Sealer extrusion	4	0.203 (0.021, 1.999)	0.172	5.186 (0.527, 50.999)	0.158
Short	2	-	-	-	-
Extruded GP	2	-	-	-	-
Perforation	175	-		-	
No	2	-		-	
Yes	2	-		-	
Use of sodium hypochlorite	0	1.522	0.007	0.626	0.003
No	177	1.522	0.007	0.626	0.003
Yes	177	1.522	0.007	0.626	0.003
EDTA	0	1.522	0.007	0.626	0.003
No	177	1.522	0.007	0.626	0.003
Yes	177	1.522	0.007	0.626	0.003
Postoperative factors					
Coronal status	115	1		1	
Tooth coloured restoration	5	1.214 (0.195, 7.546)	0.835	0.320 (0.035, 2.953)	0.315
Amalgam restoration	42	2.024 (0.942, 4.347)	0.071	0.512 (0.238, 1.100)	0.086
Crown	9	2.833 (0.564, 14.235)	0.206	0.366 (0.073, 1.838)	0.222
Defective	4	0.810 (0.110, 5.948)	0.835	1.280 (0.174, 9.407)	0.808
Bridge Abutment	4	0.810 (0.110, 5.948)	0.835	1.280 (0.174, 9.407)	0.808

Table 3. Univariate logistic regression assessing the association between prognostic factors (preoperative, intraoperative, and postoperative) under strict criteria and loose criteria.

Discussion

The aim of this retrospective study was to assess the outcome of root canal treatment provided by undergraduate dental students in our teaching institution. Assessment with strict criteria found that 60% of the cases were asymptomatic and showed normal periapical radiographs. When using loose criteria, about 39% of the cases showed absence of signs and symptoms of apical pathology, and reduction in size of apical lesion or evidence of bone trabeculation. Thus, 99% of the root canal treated teeth in the present study were considered asymptomatic and showed evidence of radiographic healing.

The percentage of cases with complete healing in this study was lower than previous reports.^{2,3,12} This might be due to the differences in the follow up period and also classification of the radiographic assessment. Two studies

assessed the outcome at 1 year and 2 years after treatment and reported higher success rates when strict criteria were used.^{2,3} A longer recall period provided sufficient time for healing to occur and thus increased the number of cases with complete healing. In our study, cases were recalled as early as 6 months after completion of treatment. This recall period is considered short but is inevitable for monitoring the progression of treatment provided by undergraduate dental students in our clinical setting. In addition, shorter recall periods can minimize the potential risk of patient drop-out. In another study, the outcome was assessed 4 to 6 years after treatment; 85% of the cases were found to be healed. In the protocols described in the study, PAI scores 1 and 2 were pooled together and considered as healed. In contrast, only cases with PAI 1 were counted as completely healed in our study. Under similar protocols, the success rate in our study would be comparable to the reported study (87%).

Utilizing plain radiography to assess endodontic treatment outcome has been found to be less accurate in detecting periapical lesions when compared to CBCT.^{11,13,14} The result from previous study showed that the healed rate of apical periodontitis following primary root canal treatment was 87% and 62.5% when assessed using periapical radiograph and CBCT, respectively.¹⁴ Nevertheless, installation of CBCT machine incurs a high cost and is not available yet in our clinic. Thus, within this study limitation, a periapical radiograph is still practical for assessing outcomes.

In our study, the preoperative factor having a significant effect on the success of root canal treatment was status of the periapical area. Cases scoring PAI 1 and 2 had higher success rates when compared against cases with PAI score ≥ 3 . More than 80% of the cases with PAI 1 and 2 showed complete healing during review whereas less than 50% of cases with PAI 5 and 6 completely healed. This finding is consistent with other studies reporting that the presence of apical periodontitis resulted in lower chances of healing when compared to non-periodontitis cases.¹ This result is not surprising because in non-periodontitis cases, infection is not extensive and can be easily eradicated by chemomechanical debridement procedures. Other preoperative factors such as type of restoration, tenderness to percussion or

palpation and presence of sinus tract did not have significant impact on the treatment outcome in this study. Contradictory to our findings, other researchers have reported that the presence of sinus tract is an important prognostic indicator for treatment outcome.³ The sinus tract facilitates the influx of bacteria from the oral cavity, facilitating colonization of the the periapex and predisposing the tooth to extra-radicular infection.³ The discrepancy between the findings may be attributed to a larger sample size in their study (n=1170).

Several intraoperative factors have been reported to improve the success of root canal treatment. These include achievement of patency at the canal terminus, extension of canal cleaning as close as possible to its apical terminus, absence of tooth/root perforation, absence of root-filling extrusion and root filling with no voids.^{3,15} Because of the limited information, only two factors were investigated in our study; apical level of root filling and perforation. Higher success rates were expected when the root filling was within 2mm from the radiographic apex.¹⁵ Short root fillings may leave the apical area in the root canal infected, which can be the reason for unhealed apical lesions. Extruded root filling is usually preceded by over-instrumentation where the infected dentin chips are forced into the apical tissue inducing inflammatory reactions.¹⁶ In our study, only 6 assessed cases presented substandard quality of root filling (4 short, 2 extruded) which had no significant effect on the outcome. Two cases with short root filling were completely healed whereas the other two cases were asymptomatic and showed radiographic healing. In the two cases presenting with extruded gutta-percha, complete healing was observed in one case and radiographic healing was observed in the other case. Surprisingly, the case with complete healing presented a higher PAI score preoperatively (PAI 5 vs PAI 4). This can be due to differences in the time of review; the former case was reviewed at 13 months and the latter was at 7 months post treatment. Extrusion of the sealer did not have significant impact on the outcome. Most of the cases with extruded sealers had healed completely. Our finding is in agreement with the previous report.¹⁷

Tooth/root perforation is a procedural accident that can happen during root canal treatment. It is considered as an important predictor for failure in cases with pulpal

necrosis.¹⁶ The presence of root perforation at the coronal or mid-root level was found to significantly reduce the odds of success by 70%, possibly attributable to bacterial contamination during or after treatment.³ Immediate repair with proper materials can prevent the establishment of the infection at the perforation site and promote healing. Two cases in our study were recorded with cervical perforation which were repaired immediately. Complete healing occurred at 1 year and 2 years recall.

Good quality of coronal restoration is very important to prevent reinfection of the root canal system and also to protect the tooth. Restoration is considered as unsatisfactory when there is: (i) obvious signs of exposed root filling and (ii) potential leakage as indicated by marginal defects and history of decementation.³ None of our cases fulfill the criteria mentioned, however 9 cases in our study presented with fractured composite restoration. The effect this had on overall outcome was not significant as eight of the cases showed complete healing.

Most of the cases in our study were restored with either tooth-colored restoration or crown. Only a few cases were restored with amalgam. Regardless of the type of restoration provided, we found that the outcome was not significantly affected. This finding is similar with the previous reports which also found no correlation between the type of restoration and periapical healing.^{3,18}

The findings of our study reveal that operator experience was not a critical factor for successful root canal treatment outcome. All cases reviewed in our study were treated by undergraduate dental student with less than 3 years of clinical experience. If similar assessment protocols were implemented, the results are expected to be comparable to previous reports where the treatment is performed by more experienced operators.^{1,3} Nevertheless, the results should be extrapolated with caution as in undergraduate dental clinic, most of the cases treated are less complex and easier to perform and thus may not be truly represent the overall situation.

Conclusions

Within the limitation of our study, the success rate of primary root canal treatment was 60% when using strict criteria. Preoperative

periapical status was the only factor that had a significant influence on treatment outcome.

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Declaration of Interest

The authors report no conflict of interest.

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