An audit of obturation quality of endodontically treated teeth by examination of immediate post-operative radiographs

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DFT 2018
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Introduction

There is a growing need for clinically effective root canal treatments, as reflected by the decreasing edentulous population (1). By being able to analyse an immediate postoperative radiograph, we are able to judge whether the technical quality (2)(3) of obturation is appropriate. It involves blocking the passage of micro-organisms and fluid along the root canal, as well as dentinal tubules and accessory canals. With better obturation, more confidence is gained in long term success, as well as prioritising what is in the patient's best interest by reducing the risk of retreatment or extraction.

To improve the quality of treatment, the variation in obturation quality is an important area in endodontics to assess through a clinical audit. The European Society of Endodontology has formulated broad quality guidelines that can be used to benchmark performance against (4).

Aim

To assess obturation quality of endodontically treated teeth by examination of immediate post-operative radiographs.

Objective

To determine whether obturation quality from endodontically treated teeth appropriately meet the guidelines set out by 'The European Society of Endodontology' through assessing radiographs against three criteria.

Audit Criteria and Standards

Criteria has been based on the ‘The European Society of Endodontology’ (4), however there are numerous journals detailing different quality parameters that have also been considered (5)(3). To ensure criteria are reliable and valid, those which are more objectively visible on radiographs have been prioritised.

- Radiographic software can objectively measure how close root fillings are to the radiographic apex.
- The presence of radiolucent voids is clearly visible as the consistency should be uniformly radiopaque.
- Any iatrogenic damage such as ledges, perforations and fractured files within a canal can be seen,

Rafeek et al. examines curvature and taper for obturation quality, however as we are assessing a volume of space, taper cannot be accurately assessed if it falls within the direction of the viewing plane (3). Curvature is dictated by root morphology which is to be expected to an extent. Extreme curvature could be a potential quality factor towards the root apex as these are more difficult to fill. As before, curvature cannot be accurate assessed in a two-dimensional view, therefore it will be excluded. Standards have been set at 100% as emphasis is placed on long term endodontic success. In practice, if criteria are not met, there are opportunities to repeat the obturation. However, where more technical issues arise such as irreversible procedural errors, referral to endodontists would be the more appropriate option.

	Criteria	Standard	Notes
1	Root filling ending within 2mm of radiographic apex	100%	**Definition** *Root filling* - consisting of Gutta percha *Radiographic* apex – terminal end of root canal shown on a periapical radiograph
			Exception Radiographs with multiple root fillings should not show overlap towards the apex affecting measurements.
2	Homogenous obturation with absence of voids	100%	**Definition** *Obturation* – The procedure used for filling and sealing the root canal (6) *Voids* – Radiolucent changes in root filling
			Exception None
3	No procedural errors	100%	**Definition** *Procedural errors* - ledge, perforation, presence of fractured instrument
			Exception Clinical records may have records of procedural errors. Only radiographic evidence will be assessed

Methodology

Initial retrospective audit

Postoperative periapical endodontic radiographs from the current six dentists in the practice will be examined from September and October 2018.

No restrictions will be placed on the use of different endodontic techniques regarding canal preparation or sealant as realistically, individual preference does exist.

Radiographs examined will be of QA grade 1 or 2, to improve data validity. A single examiner will assess the radiographs to avoid inter-operator errors. To improve intra-operator variability, this single examiner will assess the same sample pool of 10 radiographs on two different occasions to ensure results are consistent.

The individual and summary pro-forma sheets will allow the examiner to easily record whether criteria have met standards. Radiographs will be allocated a reference number to maintain confidentiality.

Data analysis will highlight any required changes and improve on the results of the prospective audit. The effectiveness of any changes will be measured by the same data collection and methods.

Re-audit

After the initial cycle, a practice meeting will be held to discuss results to highlight areas of improvement. An action plan will be formulated and immediately implemented. The re-audit will take place over another two month period, and further reassessed.

Initial Audit Results

Below, Table 1 shows the data gathered. It is crucial to note that the sample size across two months is 21, possible reflecting underrepresentation of individual dentist performance. Two completed root canal treatments did not have post-operative radiographs at the time of data collection – these were still included in analysis for completeness.

Table 1 – Initial Audit Summary Proforma

Patient Reference	Criterion 1	Criterion 2	Criterion 3	All Met?	Dentist Reference	Notes
1	x	x	x	x	F	
2		x	x		A	
3					A	No post op PA
4					F	No post op PA
5		x	x		F	
6		x	x		F	
7		x	x		A	
8	x		x		B	
9	x	x	x	x	C	
10		x	x		E	
11	x	x	x	x	B	
12	x	x	x	x	A	
13	x	x	x	x	C	
14		x	x		F	
15	x	x	x	x	C	
16	x	x	x	x	D	
17	x	x	x	x	C	
18	x	x	x	x	C	
19	x	x	x	x	A	
20			x		A	
21	x	x	x		E	

Figure 1 shows that only 52.4% of root canal treatments met all criteria listed out.

Figure 1 - Pie chart showing percentage of completed endodontic treatments that meet the overall criteria

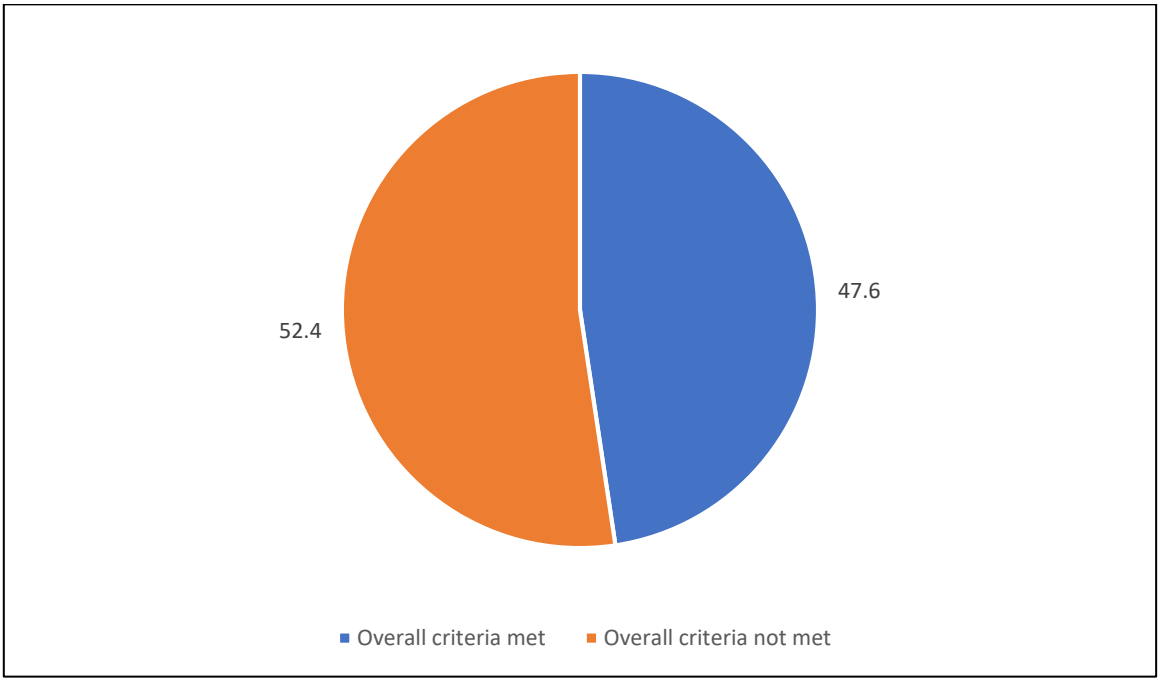


Figure 2 shows the individual criteria percentage, it is important to note that obturating within 2mm of radiographic apex shows the biggest weakness in root canal treatments (57%). Whereas, homogenous obturations and lack of procedural errors perform much better 80-90%.

Figure 2 - Bar chart showing percentage of individual criteria met

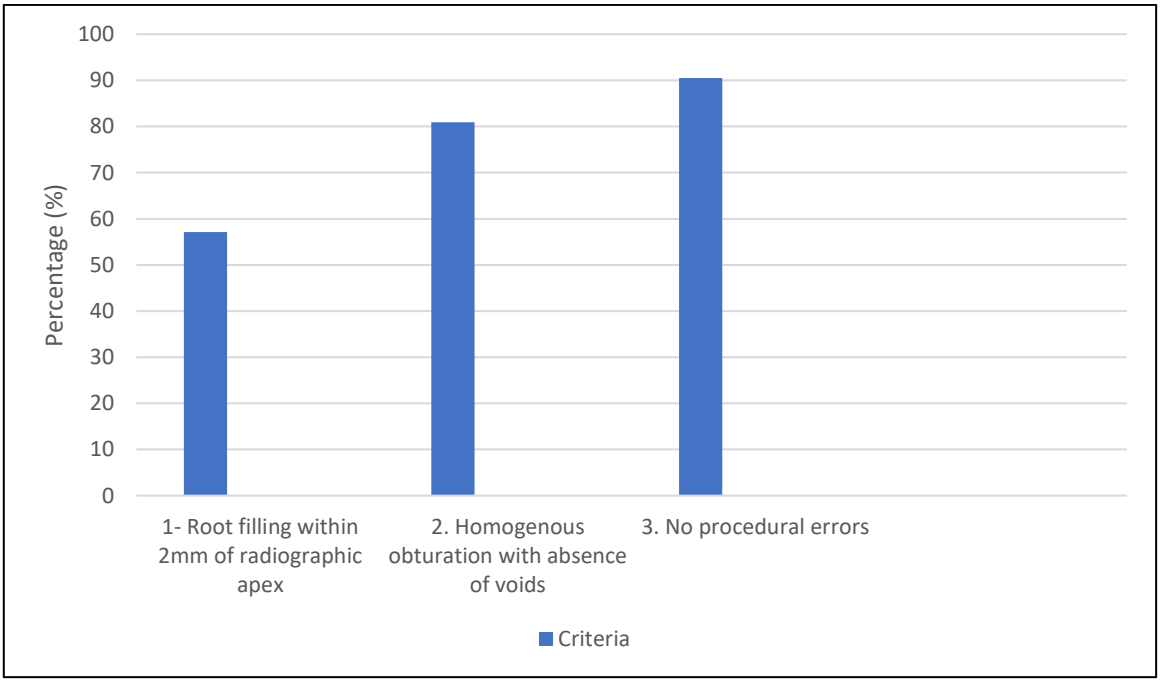
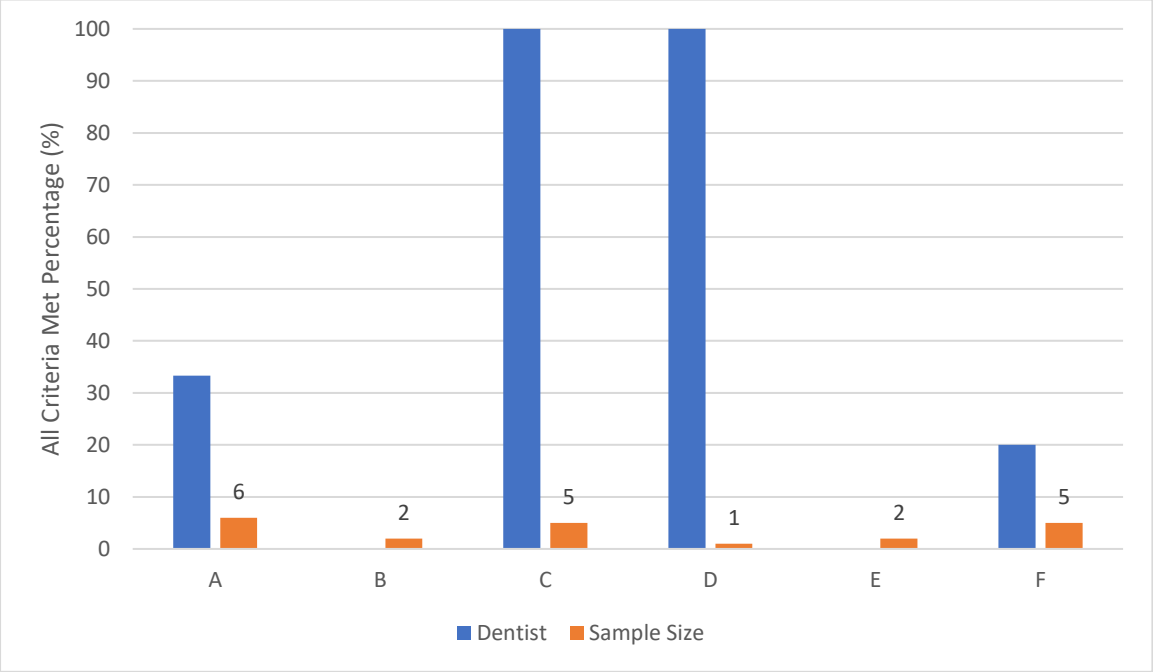


Figure 3 shows the performance of each dentist. Dentist C appears to be performing the best with 100% criteria met with a larger sample size of five. Whereas others are a lot lower.

Figure 3 - Bar chart showing each dentist's percentage of meeting all criteria



Audit Compliance

Audit compliance for individual criterion will be calculated through:

$$audit\ compliance = \frac{\text{compliant number} + \text{exception number}}{\text{Total number}} * 100$$

Table 2 - Audit compliance results

Criteria	Number of compliants	Number of exceptions	Audit Compliance (%)
1	12	0	57.14
2	17	0	80.95
3	19	0	90.48

The results above in Table 2 mirror those shown in Figure 2 as no exceptions were met.

Recommendations

As the audit had all criteria not meeting the appropriate standard, all clinicians should refamiliarise themselves with 'The European Society of Endodontology' (ESE) guidelines (4). Through team meetings and peer reviews, clinicians with a higher endodontic success from this audit can share practical advice. Those clinicians requiring further training should be encouraged to attend Continuing professional development (CPD) events. As obturating within 2mm to the radiographic apex is the biggest weakness, the use of master cone radiographs is recommended as this is the final adjustable stage before obturation completion.

Action plan

Issue identified	Action required	Who	When
Below Standard Root filling ending within 2mm of radiographic apex	Master cone radiograph required before obturation	Clinicians	Immediately
Below Standard Homogenous obturation with absence of voids	CPD regarding appropriate obturation techniques. Peer review.	Clinicians	Immediately
Below Standard No procedural errors	CPD regarding appropriate use of different types of files. Peer review.	Clinicians	Immediately

Re-audit Results

Table 3 below shows the re-audit data. The sample size is much smaller than previously. A possible reason is that prior to holiday periods, patients could be more likely to avoid additional costs or multiple longer appointments as priorities shift.

Table 3 - Re-audit Summary Proforma

Patient Reference	Criterion 1	Criterion 2	Criterion 3	All Met?	Dentist Reference	Notes
1	x	x	x	x	B	
2	x				B	Stripping, void present
3	x	x	x	x	B	
4	x	x	x	x	D	
5	x	x	x	x	F	
6	x	x	x	x	A	
7	x	x	x	x	C	
8	x		x		B	

Figure 4 - Pie chart showing percentage of completed endodontic treatments that meet the overall criteria

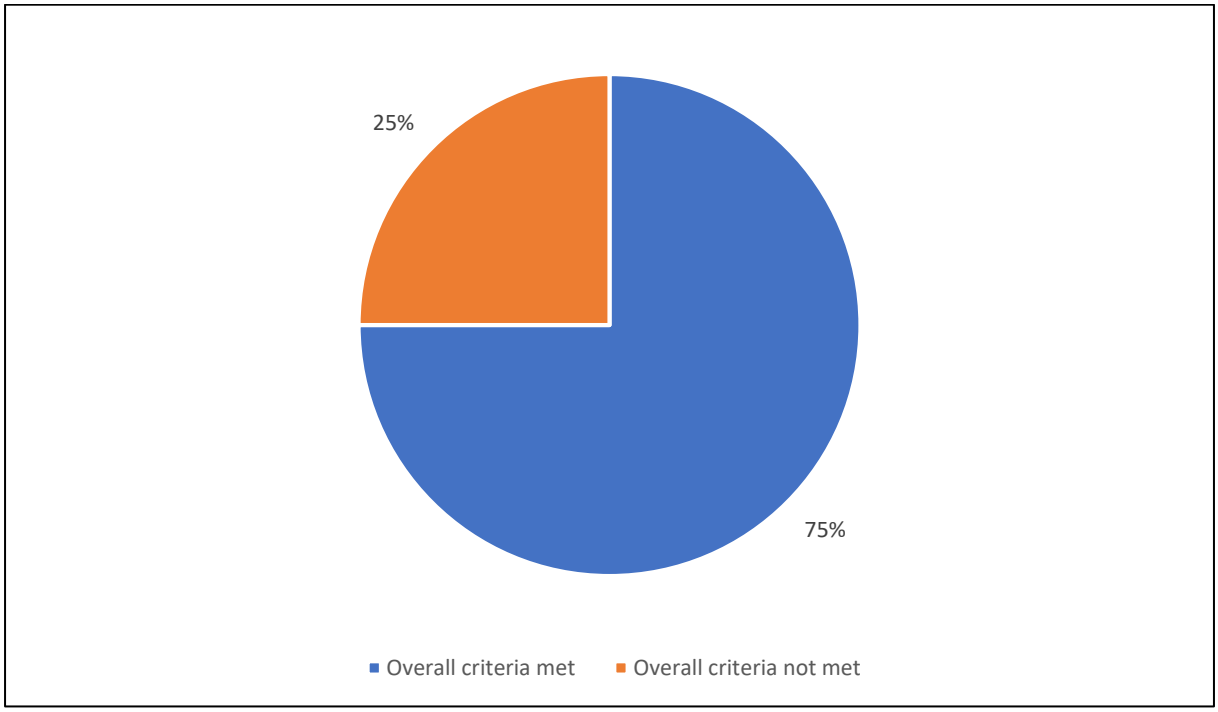


Figure 4 shows that the percentage of all criteria being met has improved compared to the initial audit (47.6% to 75%)

Figure 5 - Bar chart showing comparison of percentage of individual criteria met

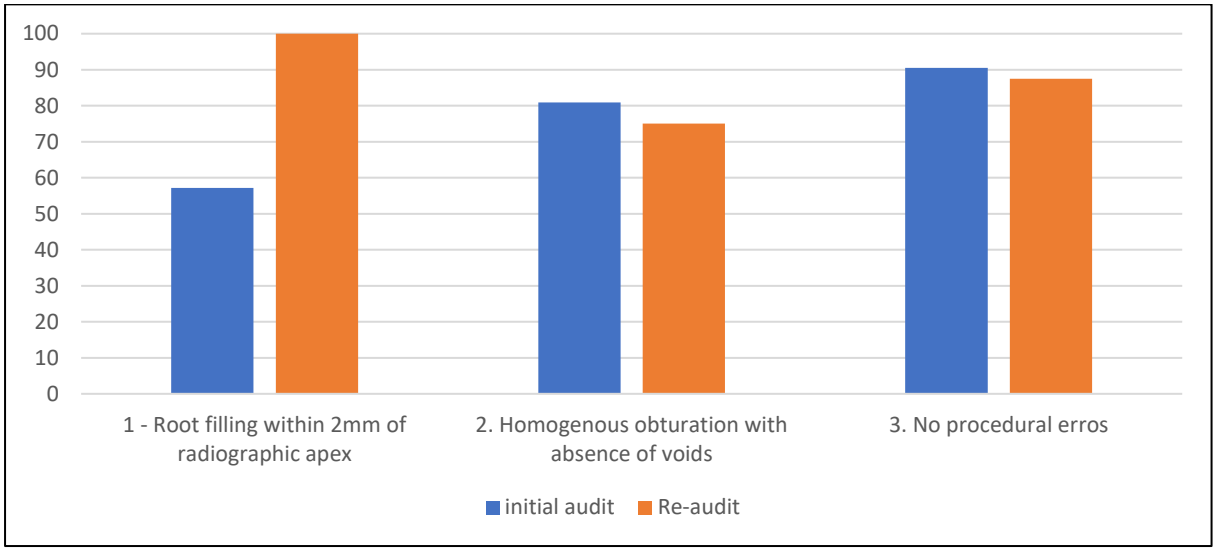


Figure 5 shows that obturating within 2mm of the radiographic apex has been achieved to 100%, almost doubling from the previous results. The other criteria have remained similar.

Figure 6 - Bar chart showing each dentist's percentage of meeting all criteria in both audits

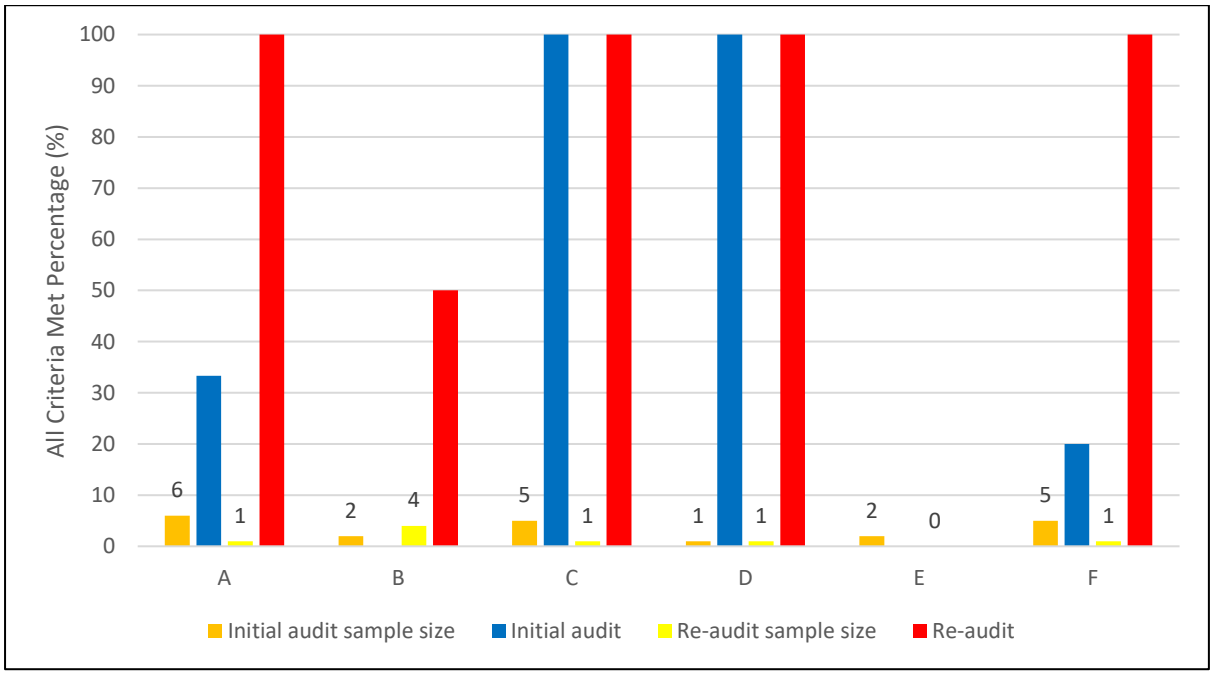


Figure 6 shows a comparison in dentist performance from both audits, at face value, all dentists appear to have improved. Only Dentist B has not met all criteria, however the same dentist has performed the most treatments in the re-audit. Small sample

sizes have introduced further bias. Note – Dentist E has not carried out any treatment in the re-audit.

Audit Compliance

Table 4 - Re-audit compliance results

Criteria	Number of compliants	Number of exceptions	Audit Compliance (%)
1	8	0	100.00
2	6	0	75.00
3	7	0	87.50

Recommendations

The previous audit highlighted that obturating within 2mm of the radiographic apex had been the biggest weakness, whereas now, the criterion compliance has been 100%. However, the other criteria have lowered slightly in compliance. Overall, the results do not seem as representative as the previous audit due to a smaller sample size. The action plan listed below has become more refined, however a larger sample size would be required for further re-audits to reduce bias. Another important aspect to consider is that, if more difficult root canal treatments are being attempted, the risk of criteria not being met will increase. Awareness of appropriate assessment of endodontic case difficulty is crucial in referral decision making. The American Association of Endodontists have produced an assessment form and guidelines (8) to help practitioners of differing experience.

Action plan

Issue identified	Action required	Who	When
Below Standard Homogenous obturation with absence of voids	CPD regarding appropriate obturation techniques. Peer review.	Clinicians	Immediately
Below Standard No procedural errors	CPD regarding appropriate use of different types of files. Peer review.	Clinicians	Immediately

Appendix

Summary Proforma

Patient Reference	Criterion 1	Criterion 2	Criterion 3	Dentist Reference	All Met?	Notes
1						
2						
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Individual Proforma

Patient Reference:		
Dentist Reference:		
Criteria		**Met?**
1	Root filling ending within 2mm of radiographic apex	
2	Homogenous obturation with absence of voids	
3	No procedural errors	
4	Correct number of canals root filled	

Overall criteria met?	

Notes

References

1. Steele JG, Treasure E, Pitts NB, Morris J, Bradnock G. Total tooth loss in the United Kingdom in 1998 and implications for the future. Br Dent J [Internet]. 2000;189(11):598–603. Available from: http://www.ncbi.nlm.nih.gov/pubmed/11132690

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5. Smadi L, Hammad M, El-Ma'aita A. Evaluation of the quality of root canal treatments performed by dental undergraduates: Is there a need to review preclinical endodontic courses? Am J Educ Res. 2015;3(12):1554–8.

6. Mosby. Mosby's Medical Dictionary. 8th ed. 2009.

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8. Aae.org. (2019). [online] Available at: https://www.aae.org/specialty/wp-content/uploads/sites/2/2017/10/2006casedifficultyassessmentformb_edited2010.pdf [Accessed 6 Jan. 2019].