



Original Research Article

Successful endodontic treatment performed by dental students: Adjustable factors to maximize success probabilities

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ABSTRACT

Aim: A successful Endodontic Treatment means the functional restoration of the tooth, whose healing is characterized by the absence of symptoms and clinical and radiographic signs. The objective of this work was to assess the Endodontic Treatment performed by undergraduate students and to determine the factors that optimize therapeutic effectiveness.

Materials and Methods: This prospective study was to identify root canal treatments of more than one year and carried out as part of the clinical internship of the students. The quality of the treatments was evaluated from the root canal filling (Working length, density of root filling, iatrogenic errors) and coronal restoration (restoration materials, fracture). The ability to chew, the absence of pain and the X-rays of the lesions were used to estimate the success rate.

The data collected was processed with the SPSS Version 17 software (Inc., Chicago, IL, USA).

Results: Fifty teeth (50) corresponding to 50 patients were assessed. The Endodontic Treatment were between one and five years old. They were of acceptable quality ranging from 56% to 98% according to the evaluation criteria. Treatment was effective in healing 76% to 92% of cases. The success rate was estimated at 86%.

Conclusion: Students performed endodontic Treatment of acceptable quality for all teeth. The results of this study focused on factors that can improve the recovery rate. These are prognostic factors such as good oral hygiene and excellent coronal sealing that can optimize the chances of successful therapy.

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1. Introduction

The quality of [endodontic treatment (ET)] is evaluated by immediate post-operative X-ray analysis to estimate conicity, density, filling at the apical limit, and possible surgical errors.¹ Although the absence of clinical and radiographic symptoms and signs during a medical assessment is evidence of successful therapy, the appearance, persistence or progression of a periapical lesion with symptoms is considered a failure.² Many factors are related to successful therapy. The complexity of root canal anatomy means that the shaping and filling

steps are tedious. This makes it even more difficult for the inexperienced dental surgeon. In addition, the infected root canal system cannot be completely sterilized by current root canal techniques.^{3,4} To meet these limits, the treatment objective must be expressed in terms of "reduction of the risk of secondary infection of the canal and aggravation of pre-existing periapical lesion."⁵ The assessment from the first post-operative year allows to objectively cure and therefore to consider that the treatment objectives have been achieved.

Undergraduate students performing root canals are supervised by endodontic staff. Once the supervisor approves the therapeutic indication, the students

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independently go through the surgical sequences until the end of the treatment. Previous studies have shown that the ET performed by students can be of excellent or acceptable quality or poor quality.^{6,7} These differences are related to the multitude of factors to be considered when assessing the quality of the treatment. Indeed, the comparison between studies on ET evaluation is limited because the means of implementation are disproportionate according to geographical areas, both in the resources allocated to treatment and in the technological innovations available.^{8,9} For example, some dental schools still use stainless steel handheld instruments, while the wealthy adapt learning to innovations in endodontic instruments using rotary nickel-titanium instruments.

Regardless of the means of implementing the treatment, undergraduate students should be able to perform good-quality root therapy.^{10,11} At the dental school, endodontic treatment is performed using manual stainless steel instruments and a single cone filling technique. The objective of this work was to assess the ET performed by undergraduate students and to identify factors of optimized therapeutic efficacy.

2. Materials and Methods

This prospective descriptive study was designed to identify the more than one-year-old ET and was carried out by the students during their clinical internship.

The study was approved by the Ethic supervision Oversight Committee of the Abidjan School of Dentistry and Stomatology, Felix Houphouet-Boigny University (No. 043/UFROS dated September 12, 2018).

2.1. Eligibility criteria

The care records of the Department of Conservative Dentistry and Endodontics were reviewed. The inclusion criteria were to keep only properly documented records containing information on patient identification (gender, medical and dental history), tooth and reason for first visit, positive and etiological diagnosis of the identified pathology, root canal shaping. (number of treatment visits, combined medication, complications), canal filling (preoperative complications, filling date, immediate postoperative complications) and coronal restoration (restoration date, material type).

From selected records, patients were notified by telephone during which the study project was explained to them for their informed consent.

The exclusion criteria were the absence, due to the extraction, of a previously treated tooth, of teeth that were supposed to be fulfilled instead they have empty canals, teeth filling the canal required the intervention of a primary supervisor and teeth sealed by a referral practitioner.

2.2. Clinical and radiographic examinations

An operator assisted by an assistant performed clinical examinations. The purpose of the interview was to describe the symptomatology of post-operative pain (intensity, duration of post-treatment, recurrence, mode of occurrence) and functional restoration of the tooth. Chewing capacity was used as a functional restoration criterion. The parameters observed were the patient's oral hygiene, palpation and periodontal pain, the type of coronal restoration and the integrity of the dental crown (fracture of the dental material or substrate). Finally, a retro alveolar x-ray (Kodak 6100[®]; Kodak, Paris, France) was performed for each tooth to assess canal filling quality and periodontal health.

2.3. Assessment criteria

The evaluations were carried out on the basis of the quality criteria established by the European Society of Endodontology²; Treatment success criteria are based on the absence of clinical and radiographic symptoms (especially pain) and signs. Four criteria were evaluated for each tooth, (1) quality ET (ability to chew, periodontal pain tests, canal filling between zero and two millimeters of the radiographic apex and iatrogenic errors); (2) coronal restoration (type of material and integrity of restoration); (3) condition of the periodontal surface (inflammation, supragingival calculus, periodontal pockets); (4) and deep periodontal state (enlargement of periodontal ligament space, periapical lesion, root resorption). The success rate was estimated from pain-related variables, chewing ability, percussion sensitivity, and radiographic evidence of enlarged periodontal ligament, periapical lesions, and root resorption.

3. Descriptive analysis

The data collected was processed with SPSS version 17 software (Inc., Chicago, IL, USA). Qualitative variables were compared using the Pearson chi-square test with a 5% level of significance.

4. Results

The ET collected one to five years ago revealed that 102 patients who met the inclusion criteria had been treated by students. Fifty-eight (58) of them were present for the assessment, representing a 57% recall rate. The clinical observation excluded eight of them for the absence of pre-treated teeth. In the end, 50 teeth corresponding to 50 patients for ET from one to five years ago were selected. The majority of medical assessments are beyond two years after the intervention (Table 1). The teeth involved were primarily molars (48%) (Table 2) and pain was the primary reason (86%) for the consultation (Table 3). Most of the conditions

for which the ET was reported were pulpitis (Table 4). Most of the time, students complete ET in two or three visits, 52% and 32% respectively (Table 5). End-of-treatment data revealed coronal restorations of amalgam (64%), composites (14%) and temporary material, Zinc Oxyde-Eugenol cement (ZOE) (22%) (Table 6). In the clinical evaluations, participants reported recurrent pain on a few teeth (10%), loss of coronal substance (20%) and increased exposed root capacity (34%) (Table 7). One out of two patients had poor oral hygiene characterized by pockets of stones and periodontal. Retro alveolar radiographs showed inadequate root fillings based on quality criteria, enlarged periodontal ligament space (24%) and periapical lesion (8%) (Table 8). An endodontic file fragment left in one of the roots was the only iatrogenic error detected. The estimated success rate was 86% (Table 9).

Table 1: Distribution of post-operative assessment years

| Postoperative years | n | % |
|-----------------------|----|-----|
| Between 1 and 2 years | 4 | 8 |
| Between 2 and 3 years | 13 | 26 |
| Between 3 and 4 years | 19 | 38 |
| Between 4 and 5 years | 14 | 28 |
| Total | 50 | 100 |

Table 2: Distribution of endodontically treated teeth

| Tooth type | n | % |
|------------|----|-----|
| Incisor | 12 | 24 |
| Canine | 0 | 0 |
| Premolar | 14 | 28 |
| Molar | 24 | 48 |
| Total | 50 | 100 |

Table 3: Distribution of patients' reasons for treatment visits

| Reasons for consultations | n | % |
|---------------------------|----|-----|
| Pain | 43 | 86 |
| Aesthetic | 5 | 10 |
| Prosthetic indication | 2 | 4 |
| Total | 50 | 100 |

Table 4: Distribution of endodontic treatment indications

| ET indications | n | % |
|------------------------------|----|-----|
| Acute pulpitis | 25 | 50 |
| Chronic pulpitis | 10 | 20 |
| Necrotic pulp | 5 | 10 |
| Abscess | 4 | 8 |
| Chronic apical periodontitis | 4 | 8 |
| Restoration indications | 2 | 4 |
| Total | 50 | 100 |

Table 5: Distribution of the required number of endodontic treatments visits

| Number of treatment visits | n | % |
|----------------------------|----|-----|
| Single visit | 8 | 16 |
| Two-visits | 26 | 52 |
| ≥ three-visits | 16 | 32 |
| Total | 50 | 100 |

Table 6: Distribution of coronal restorations materials

| Coronal restorations | n | % |
|--------------------------|----|-----|
| Amalgam | 32 | 64 |
| Composite | 7 | 14 |
| Temporary filling (ZOE)* | 11 | 22 |
| Total | 50 | 100 |

ZOE, Zinc Oxyde-Eugenol cement

Table 7: Distribution of clinical assessment criteria

| Clinical assessment criteria | Yes n (%) | No n (%) |
|-------------------------------------|-----------|----------|
| Pain | 5 (10) | 45 (90) |
| Chewing ability | 41 (82) | 9 (18) |
| Coronal restoration | 33 (66) | 17 (34) |
| Coronal fracture | 10 (20) | 40 (80) |
| Calculus | 24 (48) | 26 (52) |
| Periodontal pocket | 7 (14) | 43 (76) |
| Tenderness to axial percussion | 5 (10) | 45 (90) |
| Tenderness to transverse percussion | 10 (20) | 40 (80) |

Table 8: Distribution of radiographic assessment criteria

| Radiographic assessment criteria | Yes n (%) | No n (%) |
|------------------------------------|-----------|----------|
| Intact PDL | 38 (76) | 12(24) |
| Satisfactory root filling: [0-2]mm | 45 (90) | 5 (10) |
| Working length* | | |
| Underfilling | 3 (6) | 47 (94) |
| Overfilling | 2 (4) | 48 (96) |
| Root canal filling density | 45 (90) | 5 (10) |
| Fractured instrument | 1 (2) | 49 (98) |
| Regular periapical structure | 46 (92) | 4 (8) |

[0-2]mm Working length*: root canal filling between zero and two millimeters from the radiographic apex. PDL, periodontal ligament.

Table 9: Estimated success rates based on assessment criteria

| Assessments' results | Success rate n (%) | Failure rate n (%) |
|-------------------------|--------------------|--------------------|
| Clinical assessment | 43 (76) | 7 (14) |
| Radiographic assessment | 45 (90) | 5 (10) |
| Combined assessments | 43 (86) | 7 (14) |

5. Discussion

This study focused on the main criteria for assessing the quality of ET and the successful therapeutic endpoints. The results show a high frequency (86%) of good quality ET. There is considerable disparity in the evaluation of therapeutic interventions performed by undergraduate students. 75%. Due to the multitude of factors to be considered and the choice of evaluation criteria, these comparisons should be interpreted with caution to avoid bias.

5.1. Endodontic treatment quality and success rate

A tooth with adequate root canal filling, free of iatrogenic errors and the crown restored by a durable filling material characterizes a quality ET.² Saying "quality ET" would probably rhyme with "success ET" is logical because the first statement should naturally lead to the second. Evaluation criteria are indicators of overall quality of treatment, but do not always reflect therapeutic efficacy. For some authors, healing of dental organs is the decisive criterion, hence the recent proposal to replace the term "success" with the notion of "treatment effectiveness".⁵ In this approach, the high-frequency healing of the treated teeth in this study suggests that students perform globally effective treatments.

5.2. Evidence for an optimized treatment success

Several preoperative and post-operative factors have prognostic values for the probabilities of success of ET.¹² Data on the pathologies that motivated root canal treatment showed that the pulpitis represented half of the reasons for root canal treatment first visits. These have a higher rate of cure compared to endodontic infections and chronic apical periodontitis. Consistent with previous work, the initial condition of the tooth is a key component of the prognosis for treatment.¹³ The probability of success decreases from a healthy tooth, a pulpitis, a nondental tooth, to a tooth with periapical damage.

There is still no agreed number of ET visits to undertake as most studies have shown no significant difference between the quality of single visit and multiple-visits.^{14,15} Nevertheless, the operator's experience is relevant for the treatment duration. This was, in this study, the main reason for the two-visits or three-visits, because trainees perform the acts at their own pace for lack of dexterity. The highest cure rate for two-visits' patients is most likely due to the calcium hydroxide beneficial effects that students systematically implemented, as part of their clinical internship.

The results of this study have focused on factors for (can be corrected to) improving the success rate.

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differences between the quality of individual and multiple visits.^{14,15} Nevertheless, the experience of the operator is relevant for the duration of the treatment.

This was the main reason for the two or three visits in this study, because the trainees perform the actions at their own pace due to lack of dexterity. The highest cure rate in patients at two visits is likely due to the beneficial effects of calcium hydroxide that students have consistently implemented as part of their clinical placement.

The results of this study focused on factors that improve the success rate.

5.3. Coronal Sealing

The technical means of implementing ET may differ from school to school, but endodontic programs are being standardized.^{10,11}

Coronal sealing is a key factor in the durability of the procedure as it helps consolidate the root canal treatment performed. It was showed that adequate coronal restoration significantly increased the probability of successful treatment.¹² The results of this study suggest that coronal restoration following treatment is not systematic.

The interview revealed that patients do not always attend appointments once the tooth is asymptomatic. Patient follow-up studies confirm that about one in two patients respond positively to a recall for post-operative assessments.¹⁶ This study confirms this recall rate (57%), which was the loss of coronal restoration due to a dental material or fracture. A higher loss was noted for amalgam restorations, while only one was found for composite restorations. During their clinical internship, these students faced limited financial opportunities and late visits that resulted in severe tooth damage. Therefore, because composites have properties of residual dental structures of reinforcement, the principle of its use should be emphasized.

5.4. Oral hygiene

Overall oral hygiene of the study participants was unsatisfactory due to calculus, gingivitis and periodontal pockets. Randomized studies have shown that periodontitis health status is one of the preoperative factors with a prognostic value on the success rate of ET.¹² patients should receive explicit instructions and be motivated to take care of their oral hygiene.

Evaluation of periapical healing reveals as many teeth with bone depletion as teeth initially diagnosed with chronic apical periodontitis. However, due to the lack of prior negatives to compare with post-operative X-ray of one to five years, these results are indecisive. This is one of the limitations of this study. Another limitation is that retro alveolar radiography cannot objectify certain iatrogenic errors. To consolidate these results, it is necessary to

conduct a prospective randomized clinical trial on factors that have a prognostic value for the success rate of treatment.

6. Conclusion

Student training programs highlight the use of modern ET methods combined with techniques for the most successful outcomes. This change in practice occurs at different rates from one dental school to another, particularly for financial reasons. This study focused on the factors to be considered to optimize the success of the ET. These are simple measures to implement in practice made difficult by the precariousness of the populations and the technical platform.

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9. Conflict of Interest

The authors declare they have no conflict of interest.

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