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SUCCESS RATE OF ENDODONTIC TREATMENT AND QUALITY OF LIFE OF PATIENTS TREATED AT A HIGHER EDUCATION INSTITUTION: A DECADE-LONG RETROSPECTIVE STUDY

Narjara Gleydiely Costa de ARAÚJO[1], Natália D'avila Rodrigues PEREIRA[1], Marcelo Antônio de Souza SILVA[1], Yago Warles Silva PEREIRA[2], Maíra Ramalho MARTINS[2], Rui Barbosa de BRITO-JUNIOR[3], Luiz Renato PARANHOS[4], Felipe de Souza MATOS[5]

[1]School of Dentistry, Universidade Federal de Campina Grande, Patos, Paraíba, Brazil.
[2]Postgraduate Program in Dentistry, Faculty of Dentistry, Universidade Federal de Uberlândia, Minas Gerais, Brazil.
[3]Department of Molecular Biology, Faculty of Dentistry, Faculdade São Leopoldo Mandic, Campinas, São Paulo, Brazil.
[4]Department of Preventive and Community Dentistry, Faculty of Dentistry, Universidade Federal de Uberlândia, Minas Gerais, Brazil.
[5]Department of Endodontics, School of Dentistry, Universidade Federal de Campina Grande, Patos, Paraíba, Brazil.

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Abstract

Endodontic treatment aims to prevent or treat inflammatory and infectious processes involving the pulp and periradicular tissues. The main objective of this research was to clinically and radiographically evaluate the success rate of endodontic treatment and its impact on the quality of life of patients treated at the Dental School Clinic (CEO, in the Portuguese acronym) of the Federal University of Campina Grande (UFCG). Methods: A retrospective observational clinical study was developed, with data collected through a search in the medical records of Endodontics courses of the CEO/UFCG, interviews, and clinical and radiographic examinations. The sample consisted of patients treated between 2014 and 2023 who had completed endodontic treatment. The study included patients aged 18 or older with available medical record information. Results: The success rate of the endodontic treatments performed by dental students was 97%. The only case of endodontic treatment failure presented compromised healing (kidney disease) and a tooth with pulp necrosis and periapical lesion. The average oral health-related quality of life score was 5.0 points. The most frequent problems were mouth pain, discomfort when eating, and psychological discomfort (embarrassment or tension). Conclusions: The endodontic treatments performed at CEO/UFCG were satisfactory, with a success rate of 97%, and there was little negative impact from the oral disorder.

Keywords: Endodontics. Quality of Life. Treatment Failure.

Corresponding author:
Luiz Renato Paranhos
paranhos.lrp@gmail.com

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1. Introduction

The main objective of endodontic treatment is to prevent or treat inflammatory and infectious processes involving the pulp and periradicular tissues. Clinicians must understand patients' pathologies to provide satisfactory therapeutic conduct. These professionals are responsible for knowing the etiological and physiopathological aspects of pulp and periradicular diseases and their clinical manifestations. Several problems, such as disease recurrence, are due to technical failure, incomplete treatment, and inadequate conduct. Thus, dentists must have scientifically based knowledge and remain updated on treatment protocols for these diseases (Fransson and Dawson 2023).

Preoperative, intraoperative, and postoperative factors may influence periapical healing after endodontic treatment (Gulabivala 2023). Periradicular tissue healing and the consequent success of endodontic therapy only occur without clinical signs and symptoms, including the absence of periapical lesions or thickening of the periodontal ligament. Periapical lesion size highly affects the success rate of root canal treatments, considering that larger lesions are associated with lower success rates (Da Rocha et al. 2022).

The impact of systemic health on endodontic treatment outcomes is little known (Aminoshariae et al. 2017). However, evidence confirms systemic diseases interfere with endodontic infections and may modify general health. Systemic diseases are associated with higher inflammation and bone resorption in the periapical region, and dental materials may change the biological markers of these diseases (Cintra et al. 2018). Diabetes mellitus, cardiovascular, kidney, and gastrointestinal diseases, and rheumatoid arthritis affect endodontic treatment outcomes (Alghofaily and Fouad 2022). Diabetes mellitus has the most influence on endodontic therapy outcomes, compromising immunity by affecting cell responses from inflammatory markers, facilitating infection, chronic inflammation, periapical tissue destruction, and complicating tissue repair (Gupta et al. 2020).

Quality of life has been related to patient health since the World Health Organization (WHO) acknowledged health as comprehensive physical, psychological, and social well-being. Hence, oral health directly interferes with daily activities such as speaking, eating, and smiling (Diniz-De-Figueiredo et al. 2020). Oral health-related quality of life (OHRQoL) indices are vital for treatment planning because they enable the assessment of pain absence and overall patient well-being. The OHRQoL also weighs the advantages of different endodontic treatments (conservative, radical, retreatment, and periradicular surgery) for patients (Neelakantan et al. 2020).

Studies have identified several challenges dental students face during endodontic treatment, such as difficulties performing radiographic examinations, particularly distinguishing root canals, and selecting the appropriate intracanal medication (Tavares et al. 2019). Students have also experienced anxiety before and during endodontic procedures, and surgical access was the stage in which they felt the least confident (Eloy et al. 2022). The success rate of endodontic treatments performed by undergraduate students varied according to the initial diagnosis, reaching 96.7% for vital pulp cases, 87.5% for pulp necrosis, and 92.9% for retreatments (Zajkowski et al. 2020). Predictive factors for treatment success included the treated tooth, initial diagnosis, initial periapical radiographic index, and the number of treatment sessions (Zajkowski et al. 2020). These findings highlight the relevance of addressing the challenges perceived by students to improve endodontic education and clinical outcomes.

Postoperative follow-up is required after concluding endodontic treatment to assess technical efficacy, thus promoting higher safety and preventing severe complications to the treated tissue in case of treatment failure. The mean time for healing periapical lesions is 11.78 months (Azim et al. 2016). Clinical and imaging examinations every six months in a postoperative period of at least one to four years are recommended to verify complete healing or treatment failure (Antunes et al. 2017). In this context, the present study clinically and radiographically evaluated endodontic treatment success rates and their interference with the quality of life of patients assisted at a Brazilian federal dental school. The findings are relevant to determining the technical quality of the provided services and establishing new strategies for early diagnosis and treatment.

2. Material and Methods

Study design and registration

The retrospective observational clinical study followed the PROBE 2023 guidelines that established the preferential items of observational study reports in endodontics (Nagendrababu et al. 2023). The study protocol received the approval of a local Research Ethics Committee (protocol: 5.935.062). It complied with the legal and ethical principles of Resolution 466/12 of the Brazilian National Health Council and the Declaration of Helsinki. All participants signed an informed consent form.

Population and eligibility criteria

The population included patients who completed root canal treatment between 2014 and 2023 at the Dental School Clinic of the Federal University of Campina Grande (UFCG) in Patos, Paraíba, Brazil. Considering the data collected from institutional records, the study included patients aged 18 years or older with complete dental records, including clinical and radiographic data, and who had completed endodontic treatment for at least one year. Individuals with intellectual disabilities, endodontically treated tooth missing or decayed, and deficient, cracked, and/or fractured restorations were excluded. All patients were recruited by telephone, according to medical record data. The study excluded participants who were not contacted or refused to participate in follow-up evaluations.

Endodontic treatment protocol

Undergraduate dental students performed all endodontic treatments in multiple sessions. Initially, the patients underwent anamnesis and clinical and radiographic examinations to diagnose and determine the temporary working length. The treatment began by administering local anesthetics and performing absolute isolation with a rubber sheet; then, coronal opening, canal exploration, and actual working length definition with the Finepex apical locator (Schuster, Santa Maria, RS, Brazil) and/or periapical radiographs. The crown-apex technique promoted chemomechanical preparation using Gates-Glidden drills (Dentsply, Petrópolis, RJ, Brazil) for pre-enlargement and manual stainless steel files (Dentsply, Petrópolis, RJ, Brazil) for canal instrumentation up to 1 mm short of the root apex. The apical expansion was performed with up to two or three instruments above the initial anatomical apical diameter. Manual stainless steel files sized 8 to 15 maintained foraminal patency. The 2.5% sodium hypochlorite (NaOCl) was the irrigating solution used in all endodontic treatment steps, and calcium hydroxide paste was the intracanal medication applied between sessions for at least 14 days. A final irrigation protocol was performed with 2.5% NaOCl, 17% EDTA, and saline under the irrigant's mechanical or passive ultrasonic agitation. The canal was filled in the absence of signs and symptoms of secondary or persistent infection by cold lateral condensation of gutta-percha with Sealer 26 (Dentsply, Petrópolis, RJ, Brazil) or MTA Fillapex (Angelus, Londrina, PR, Brazil) endodontic cement. Access cavities were later restored with composite resin, and occlusion was verified and adjusted. A post-filling radiograph was routinely taken to assess the quality of root filling and coronal restoration, serving as a reference during follow-up visits.

Data collection procedures

A form with patients' sociodemographic data and the medical and dental history was filled out based on the information available in the medical records. The analyzed demographic and clinical characteristics were sex, age, skin color, medical condition, tooth type, preoperative pain experience, pulp condition, and periapical lesions. Regarding the medical condition, the patients were divided into two groups: 1) compromised healing - patients with medical conditions that may interfere with the etiopathogenesis of the endodontic disease and affect the healing process of periapical tissues (HIV/AIDS, diabetes mellitus, cancer, hepatitis B or C, autoimmune disease, anemia, osteoporosis, heart, kidney, and liver diseases, hemophilia, and smoking); 2) non-compromised healing - healthy patients or with other medical conditions besides those

mentioned without scientific evidence of interference with the etiopathogenesis of the endodontic disease and periapical tissue healing. The study also collected details regarding the endodontic treatment, such as the number of sessions, treatment duration, memory instrument, root filling quality, and time for the final restoration. Root filling quality was radiographically classified according to the following criteria: 1) satisfactory - root filling ending 0-2 mm away from the radiographic apex, absent spaces, homogeneous root filling, good condensation, and consistent taper from the orifice to the apex; 2) unsatisfactory - root filling extending beyond the apex (overfilling) or > 2 mm short of the apex (underfilling), existing spaces, heterogeneous root filling, weak condensation, and/or no consistent taper from the orifice to the apex (Fong et al. 2018). A final-year dental student collected all the data. A professor and researcher experienced in Endodontics confirmed these data.

Success rate

The prior medical and dental history, including preoperative radiographic signs, was compared with the clinical and radiographic signs and symptoms during postoperative follow-up between one and ten years. This comparison occurred between July and August 2024 to determine endodontic treatment success. Treatment outcomes were classified into three categories according to the following definitions: 1) healed (complete healing) - the absence of clinical signs or symptoms, regular periapical tissue with intact periodontal ligament space and a hard layer, or a periodontal ligament slightly enlarged around the extruded material; 2) healing (incomplete healing) - the absence of clinical signs or symptoms and periapical radiolucency still present but small; 3) not healed - the presence of signs or symptoms and/or the emergence of new periapical radiolucency or unchanged or increased periapical radiolucency. The "not healed" category represented endodontic treatment failure, and treatment success combined the "healed" and "healing" categories (He et al. 2017).

Quality of life

The Oral Health Impact Profile (OHIP-14) evaluated the impact of endodontic treatment on OHRQoL (Slade and Spencer 1994; Wigsten et al. 2020). This questionnaire comprises 14 questions to capture seven oral health dimensions conceptually formulated: functional limitation, physical pain, psychological discomfort, physical disability, psychological disability, social disability, and social disadvantage. The patients answered how often they had experienced each of the 14 OHIP-14 affirmations one to ten years after completing the endodontic treatment. The response options were based on a five-point Likert scale and coded as very often (code 4), fairly often (code 3), occasionally (code 2), rarely (code 1), and never (code 0). The neutral options "I don't know" or "not applicable" were void. Higher scores infer a higher impact of the oral disorder. The responses were converted by addition, varying from zero to a maximum of 56 points.

Data analysis

The sample selection was quantitatively detailed according to the eligibility criteria through a flowchart. The data on demographic and clinical characteristics of the sample and the characteristics of completed endodontic treatments, along with the proportion of failures in each category, were organized in a Microsoft Excel spreadsheet and descriptively presented (frequencies, percentages, and mean ± standard deviations). The OHRQoL score was presented as mean ± standard deviation. The responses to the 14 questions in the OHIP-14 questionnaire were distributed in a table with the respective absolute and relative values.

3. Results

The study initially identified 273 medical records of patients subjected to endodontic treatment between 2014 and 2023, of which 246 were excluded due to contact failure (n = 211), refusal to participate (n = 27), missing tooth (n = 7), or decayed tooth (n = 1). Thus, 27 patients and 30 teeth endodontically treated

at the Dental School Clinic of UFCG were included and evaluated to determine the success rate and postoperative quality of life (Figure 1).

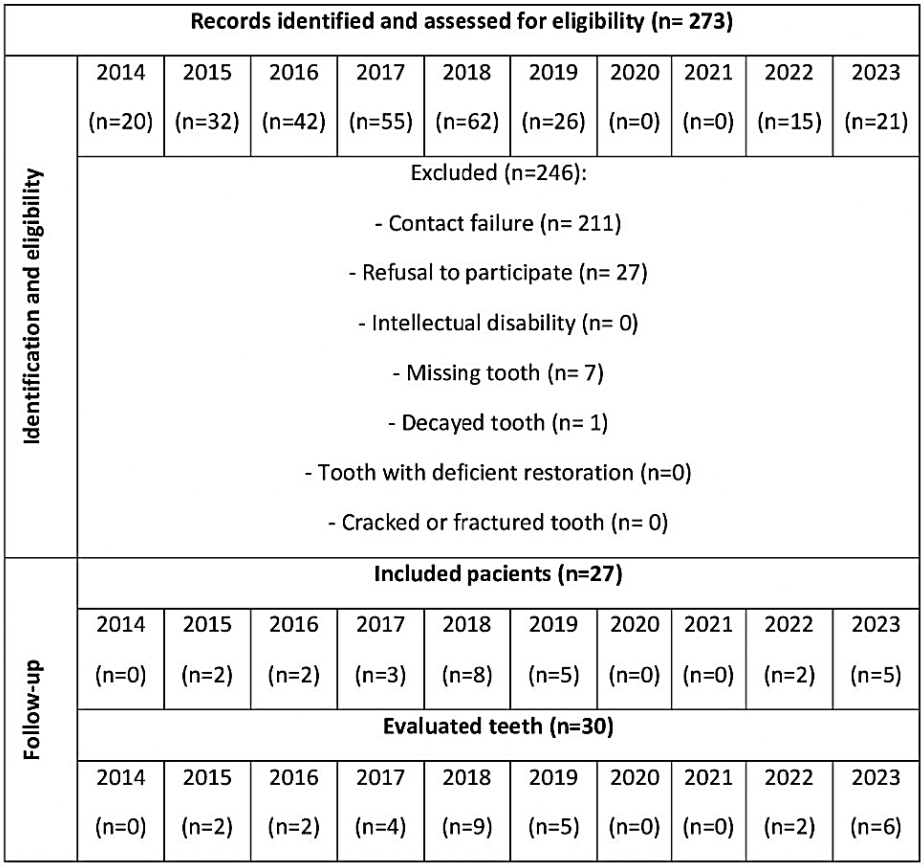

Figure 1. Identification and selection of records of patients endodontically treated at the Dental School Clinic of UFCG between 2014 and 2023.

The endodontic treatments performed by dental students at the Dental School Clinic of UFCG had a 97% success rate. The endodontic therapy failed in only one of the 30 evaluated teeth. Table 1 shows the demographic and clinical characteristics of the final sample (n = 30) and the proportion of endodontic treatment failure in each category. There was a higher prevalence of women (63%), aged 49 years or younger (63%), white (53%), and with non-compromised healing (93%).

The most treated teeth were premolars (60%), and preoperative pain occurred in most cases (60%). The most frequent condition was necrotic pulp (73%) with associated periapical lesions (57%). The only case of endodontic treatment failure presented compromised healing (kidney disease) and a tooth with preoperative pain, pulp necrosis, and periapical lesions.

Table 2 shows the characteristics of completed endodontic treatments (n = 30) and failure proportion (n = 1) in each category. Most treatments were performed in more than three sessions (63%), lasting more than two months (40%), and using a memory instrument larger than #40 (57%). Root filling quality was 100% satisfactory, and most final coronal restorations were performed up to 15 days (80%) after completing the endodontic treatment. The only case of endodontic treatment failure was concluded after three sessions, with a treatment duration of more than two months, using a memory instrument larger than #40, with satisfactory root filling quality, and final coronal restoration performed within one month after the filling procedure.

The mean OHRQoL score one to ten years after completing the endodontic treatment was 5.0 ± 9.0 (of 56 points), demonstrating little negative impact on the quality of life due to the oral disorder. Table 3 shows the distribution of OHIP-14 questionnaire responses from the 27 patients evaluated in the study. The problems with the highest frequencies were "mouth pain," with 22% of patients reporting pain in the oral cavity over the last one to ten years, followed by "discomfort when eating" (18%) and "psychological discomfort (embarrassment or tension)" (14%).

Table 1. Demographic and clinical characteristics of the final sample (n = 30) and the proportion of endodontic treatment failure (n = 1) in each category.

Variable	Evaluated tooth: n (%)	Failure: n (%)
Sex		
Female	19 (63%)	0 (0%)
Male	11 (37%)	1 (9%)
Age		
≤ 49 years	19 (63%)	1 (5%)
> 49 years	11 (37%)	0 (0%)
Skin color		
White	16 (53%)	1 (6%)
Black	3 (10%)	0 (0%)
Non-white (BYI)	11 (37%)	0 (0%)
Medical condition		
Compromised healing	2 (7%)	1 (50%)
Non-compromised healing	28 (93%)	0 (0%)
Tooth type		
Anterior	11 (37%)	0 (0%)
Premolar	18 (60%)	1 (6%)
Molar	1 (3%)	0 (0%)
Preoperative pain		
Present	18 (60%)	1 (6%)
Absent	12 (40%)	0 (0%)
Pulp condition		
Vital	8 (27%)	0 (0%)
Necrotic	22 (73%)	1 (4%)
Retreatment	0 (0%)	0 (0%)
Periapical lesion		
Present	17 (57%)	1 (6%)
Absent	13 (43%)	0 (0%)

Note: BYI - brown, yellow, indigenous.

Table 2. Characteristics of completed endodontic treatments (n = 30) and failure proportion (n = 1) in each category.

Variable	Evaluated tooth: n (%)	Failure: n (%)
Number of sessions		
1 session	0 (0%)	0 (0%)
2 sessions	0 (0%)	0 (0%)
3 sessions	11 (37%)	0 (0%)
> 3 sessions	19 (63%)	1 (5%)
Treatment duration		
15 days	1 (3%)	0 (0%)
1 month	7 (23%)	0 (0%)
2 months	10 (34%)	0 (0%)
> 2 months	12 (40%)	1 (8%)
Memory instrument		
≤ #30	3 (10%)	0 (0%)
#35-40	10 (33%)	0 (0%)
> #40	17 (57%)	1 (6%)
Filling quality		
Satisfactory	30 (100%)	0 (0%)
Unsatisfactory	0 (0%)	0 (0%)
Final restoration		
15 days	24 (80%)	0 (0%)
1 month	3 (10%)	1 (33%)
2 months	0 (0%)	0 (0%)
> 2 months	3 (10%)	0 (0%)

Table 3. Distributions of OHIP-14 questionnaire responses and the oral health-related quality of life of 27 patients evaluated one to ten years after endodontic treatment completion.

Dimension of problems with teeth or mouth	Evaluated patient: n (%)		
	0-1 Never or rarely	2 Occasionally	3-4 Fairly frequently
Functional limitation			
Difficulty pronouncing words	26 (96%)	1 (4%)	0 (0%)
Taste changes	25 (93%)	1 (4%)	0 (0%)
Physical pain			
Mouth pain	21 (78%)	4 (15%)	2 (7%)
Discomfort when eating	22 (82%)	2 (7%)	3 (11%)
Psychological discomfort			
Embarrassment	23 (86%)	2 (7%)	2 (7%)
Tension	23 (86%)	2 (7%)	2 (7%)
Physical disability			
Unsatisfactory diet	25 (92%)	1 (4%)	1 (4%)
Meal interruptions	25 (93%)	2 (7%)	0 (0%)
Psychological disability			
Difficulty relaxing	24 (92%)	2 (7%)	1 (4%)
Embarrassment	24 (92%)	2 (7%)	1 (4%)
Social disability			
Irritable with others	25 (92%)	1 (4%)	1 (4%)
Difficulty performing tasks	25 (92%)	1 (4%)	1 (4%)
Social disadvantage			
Less satisfactory life	25 (92%)	1 (4%)	1 (4%)
Completely incapable of performing tasks	26 (96%)	0 (0%)	1 (4%)
OHRQoL (mean ± SD)		5.0 ± 9.0	

Note: OHRQoL - oral health-related quality of life; SD - standard deviation.

4. Discussion

Endodontic treatment success is associated with diverse factors, such as dental clinical conditions, radiographic findings, and systemic health. The present study evaluated the success rate of endodontic treatments performed by students in a Brazilian dental school clinic and the quality of life of the assisted patients. The initial search for eligible patients using medical records collected a significant number of patients subjected to nonsurgical root canal treatment over a decade (n = 273). However, there was a contact failure (n = 211) during the selection and recruitment of research participants, providing a small patient sample (n = 27). It is worth obtaining other means of contacting patients, such as e-mails or social media, to make postoperative assessments and retrospective studies feasible.

The high follow-up loss rate among endodontically treated patients (77.2%) represents a significant limitation in assessing treatment success in this study, as it may introduce outcome biases. Patients who return for follow-up may not accurately represent the overall treated population, potentially leading to success rate over- or underestimations. Additionally, the lack of long-term monitoring hinders the identification of late complications, such as persistent periapical lesions or symptom recurrence, compromising treatment effectiveness evaluations. Sample size reduction also affects the statistical robustness of the study, limiting the generalizability of the findings to other populations. Another critical issue is the risk of underreported treatment failures, as patients experiencing unsuccessful outcomes may have sought care elsewhere without informing the institution they were initially treated. Given these challenges, implementing strategies to improve follow-up adherence (such as using multiple communication channels and raising patient awareness about the significance of returning) becomes essential to ensure retrospective study reliability and enhance dental care quality.

The demographic characteristics of the patients in this study showed that sex and age did not affect endodontic treatment success rates. It was impossible to establish an association between sex or age and endodontic treatment success rates because the total sample (n = 30) and the number of failures (n = 1) were low. Most participants were women (63%), corroborating Da Rocha et al. (2022), who also showed a prevalence of the female sex (67.9%). Regarding age, the two studies diverged, as the age group of most

participants in this research was equal to or lower than 49 years (63%), and Da Rocha et al. (2022) showed equivalent age groups, with 48.8% younger than 45 years and 51.2% older than 45 years.

The only patient who experienced endodontic treatment failure did not report preoperative pain but presented pulp necrosis and periapical lesions, which might have influenced treatment outcomes. Periapical lesions are associated with lower endodontic treatment success rates (Da Rocha et al. 2022; Jurič et al. 2024). Corroborating this assumption, Fransson and Dawson (2023) reported that vital teeth may have a higher survival rate after endodontic treatment than necrotic teeth with periapical lesions.

The association of endodontic treatment success with systemic diseases remains inconclusive in the literature, but systemic diseases may modify the inflammatory response and, consequently, patient healing (Aminoshariae et al. 2017; Cintra et al. 2018). Khalighinejad et al. (2017) stated that apical periodontitis was more prevalent in kidney disease patients. This finding only suggests an association, meaning that a conclusive outcome on cause and effect is impossible under these conditions. Similarly, the present study showed that the only failure case presented compromised healing (kidney disease), which may be a predisposing factor for procedure failure.

The available scientific evidence so far does not indicate a significant difference in healing rates when comparing endodontic treatments performed in one or multiple sessions, regardless of the preoperative condition of the pulp and periapex. Apical periodontitis patients may experience a slightly positive tendency to lower postoperative complications and higher efficacy of single-session treatments (De-Deus and Canabarro 2017; Moreira et al. 2017). Conversely, a recent study evaluated the effect of intracanal medication using calcium hydroxide. The main finding was that canal treatment in a single session is associated with better periapical repair rates at a moderate certainty level (Rossi-Fedele and Rödig 2023).

This study showed that most treatments were performed in more than three sessions, lasting more than two months, potentially suggesting higher contamination risks during therapy due to multiple coronal sealing removals (De-Deus and Canabarro 2017). Longer treatment duration may be related to operator skills and the need for constant professor supervision, considering that procedures were performed in a dental school clinic at an undergraduate level.

Root filling quality was 100% satisfactory, not presenting empty spaces and with roots apically instrumented up to 2 mm away from the root apex, indicating that instrumentation and filling techniques were well executed. This relevant fact may justify the excellent treatment success rate (97%), considering that root filling affects endodontic treatment success considerably in the long term (Aminoshariae et al. 2017; Alghofaily and Fouad 2022; Jurič et al. 2024). These findings corroborate Azim et al. (2016), who demonstrated that teeth filled within 0.5 mm of the radiographic apex provided significantly higher success rates (88%) than those with root fillings > 2 mm short of the radiographic apex (33%). A previous study by our research group demonstrated a satisfactory filling rate by dental students of around 72.6%, but the sample analyzed included only single-canal teeth (Bezerra et al. 2024).

Another factor that may have favored the high success rate in the study was the short time interval (15 days) to perform final coronal restorations after root filling. Unfortunately, the time for the final restoration and the treatment success rate could not be associated because the study had only one failure case, whose time interval for the final restoration was one month. Composite resin restorations improve the biomechanical behavior of teeth, promoting lower stress concentration and more homogeneous stress distribution (Matos et al. 2020). Gomes et al. (2015) stated that coronal restorations represent a physical barrier, preventing microorganism entry and root canal recontamination. They found high success rates for cases with final coronal restorations, suggesting that a final coronal restoration may be essential to prevent reinfection after completing the endodontic treatment.

Sabeti et al. (2024) performed a systematic review with meta-analysis, finding a low certainty of evidence that a memory instrument (apical preparation) ≥ #30 may provide a better endodontic treatment success rate based on clinical and radiographic assessments. The only endodontic treatment failure of the present study used a memory instrument larger than #40, adequate root filling, and final coronal restoration performed within one month. Despite these favorable factors, failure suggests that other aspects, such as the patient's systemic condition (kidney disease) and treatment execution in three sessions, might influence the outcome.

Wigsten et al. (2020) evaluated the influence of endodontic treatment on patients' quality of life. Overall satisfaction regarding root canal treatment in dental practice was high. These findings originated from three questionnaires, as the authors state that the OHIP-14 is a non-specific instrument. Hence, endodontic treatment assessment requires combining this questionnaire with more specific ones to reach more precise outcomes. Our study used only the OHIP-14, agreeing with previous investigations (Diniz-de-Figueiredo et al. 2020; Do Nascimento et al. 2022).

The achieved OHIP-14 questionnaire score suggests that patients' OHRQoL was little affected after endodontic treatment. Although the overall impact is low, problems such as mouth pain (22%), discomfort when eating (18%), and psychological discomfort (embarrassment or tension) (14%) indicate that, even after completing the endodontic treatment, some problems affect OHRQoL, whether related to the treated teeth or other factors interfering with oral health. The lack of preoperative OHRQoL assessment is a limitation of this study. A conclusive outcome regarding quality-of-life improvement after orthodontic treatment would require applying preoperative and postoperative questionnaires. Well-designed prospective clinical studies with adequate sample sizes should be planned to evaluate the impact of different treatment protocols on endodontic therapy success and quality of life by applying the OHIP-14 before and after treatment.

5. Conclusions

Considering the appropriate records and approached patients, the success rate of endodontic treatments performed by dental students was 97%. The only failure case presented compromised healing (kidney disease) and tooth with pulp necrosis and periapical lesion. The mean oral health-related quality of life score was 5.0, indicating little negative impact due to the oral disorder. The most frequent problems affecting patients' oral health-related quality of life were mouth pain, discomfort when eating, and psychological discomfort (embarrassment or tension).

Authors' Contributions: ARAÚJO, N.G.C.: Conceptualization, Methodology, Formal Analysis, Investigation, Data collection and Writing - Original Draft; PEREIRA, N.D.R.: Conceptualization, Methodology, Formal Analysis, Investigation, Data collection and Writing - Original Draft; MATOS, F.S.: Conceptualization, Methodology, Formal Analysis, Investigation, Data collection and Writing - Original Draft; SILVA, M.A.S.: Formal Analysis, Data Curation and Writing - Review and Editing; PEREIRA, Y.W.S.: Formal Analysis, Data Curation and Writing - Review and Editing; MARTINS, M.R.: Formal Analysis, Data Curation and Writing - Review and Editing; BRITO-JUNIOR, R.B.: Formal Analysis, Data Curation and Writing - Review and Editing; PARANHOS, L.R.: Conceptualization, Formal Analysis, Data Curation, Writing - Review and Editing and Project Administration.
All authors declare that they contributed to a critical review of intellectual content and approval of the final version to be published.

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