

ANALYSIS OF ROOT CANAL OBTURATION LENGTH IN ENDODONTIC TREATMENTS PERFORMED BY UNDERGRADUATE DENTAL STUDENTS

Análisis de longitud de obturación del conducto radicular en tratamientos endodónticos realizados por estudiantes de pregrado de odontología

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ABSTRACT

Introduction: Cross-sectional observational study whose purpose was to analyze the length of root canal obturation, according to the Barrieshi-Nussair criteria, in endodontic treatments performed by undergraduate students at the School of Dentistry at Finis Terrae University, in the year 2022.

Results: 88.5% obtained an acceptable obturation length, 6.7% were overfilled and 4.8% were underfilled. Regarding the academic year, in the 4th year, 77.8% of the endodontic treatments had an acceptable obturation length; in the 5th year, 89.4%; and in the 6th year, 90%. In the lower jaw, 89.3% were acceptable and in the upper jaw, 88.2% were acceptable. In the incisor group, 83.3% achieved an acceptable obturation length, 100% in the canines and 89.1% in the premolars.

Conclusion: The results obtained in this study were superior to some described in the Middle East, lower or similar to those found in Europe, and comparable to others reported in Chile. In all variables, the percentage of acceptable obturation length according to the *Barrieshi-Nusair* criteria was predominant (77.8% for 4th, 89.4% for 5th, 90% for 6th, 89.3% for mandible, 88.2% for maxilla, 83.3% for incisors, 100% for canines and 89.1% for premolars). This high percentage of acceptable treatments may be due, among other factors, to the use of the electronic apical locator and the accompaniment of specialists during undergraduate training and endodontic treatment.

Keywords: *Dental students; Root canal therapy; Root canal preparation; Endodontics; Root canal filling materials; Root canal obturation.*

RESUMEN

Introducción: Estudio observacional transversal cuyo propósito fue analizar la longitud de obturación del conducto radicular, de acuerdo a los criterios de Barrieshi-Nussair, en tratamientos endodónticos realizados por estudiantes de pregrado en la Facultad de Odontología de la Universidad Finis Terrae en el año 2022.

Resultado: Un 88,5% obtuvo una longitud de obturación aceptable, 6,7% sobreobturados y 4,8% subobturados. En cuanto al ciclo de estudio, en 4^o año se encontró un 77,8% de tratamientos endodónticos con longitud de obturación aceptable; en 5^o, 89,4%; y en 6^o, 90%. En maxilar inferior, 89,3% fueron aceptables y en maxilar superior, 88,2%. En el grupo incisivos, 83,3% obtuvo una longitud de obturación aceptable, el 100% en caninos y 89,1% en premolares.

Conclusión: Los resultados obtenidos en el estudio fueron superiores a algunos descritos en Medio Oriente, menores o similares a los encontrados en Europa; y similares a otros reportados en Chile. En todas las variables, según los criterios de *Barrieshi-Nusair* el porcentaje de longitud de obturación aceptable fue predominante (77,8% para 4^o, 89,4% para 5^o, 90% para 6^o, 89,3% para maxilar inferior, 88,2% para maxilar superior, 83,3% para incisivos, 100% para caninos y 89,1% para premolares). Este alto porcentaje de tratamientos aceptables puede deberse, entre otros factores, al uso del localizador apical electrónico y acompañamiento de especialistas durante la formación de pregrado y la ejecución del tratamiento endodóntico.

Palabras Clave: *Estudiantes de odontología; Terapia de conducto radicular; Preparación del conducto radicular; Endodoncia; Materiales de relleno del conducto radicular; Obturación del conducto radicular.*

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INTRODUCTION

According to the Outpatient Dental Emergencies Guide (ODE) of the Chilean Ministry of Health, the most common outpatient dental emergencies are related to toothaches of infectious and non-infectious origin in adults and dentoalveolar trauma in children. Among the ODEs are pulpal and periapical pathologies, which are an important cause of tooth loss in Chile,¹ these are classified by the American Association of Endodontists (AAE) as reversible and irreversible pulpitis and pulp necrosis; apical periodontitis and acute and chronic apical abscess.²

The treatment for many of these conditions is endodontic therapy,¹ which consists of bio-mechanical preparation and disinfection of the root canal system for subsequent obturation and sealing.³ The quality of obturation is evaluated radiographically, and considers three relevant aspects: obturation length, obturation density and conicity of the obturation; obturation length is considered to be the most reproducible and accurate parameter for evaluating obturation quality.⁴⁻⁶

The length of the obturation has been shown to be a critical factor in the success of endodontic treatment and its sequelae. There is ample evidence that when the obturation length is inadequate, the treatment success rate decreases and the postoperative prognosis is less favorable, with a prevalence of apical periodontitis of approximately 70%, as shown in previous studies.⁷⁻⁹ Recent studies³⁰⁻³² have investigated the influence of various techniques and materials on endodontic treatment outcomes, focusing on the length of obturation as a key factor in the success of endodontic treatment.

The purpose of this study was to analyze the length of root canal obturation according to the

Barrieshi-Nusair *et al.*,¹⁰ criteria in endodontic treatments performed by undergraduate students at the Faculty of Dentistry of the University of Finis Terrae in 2022.

MATERIALS AND METHODS

An observational, descriptive, and cross-sectional study in which control radiographs of endodontic treatments performed by undergraduate students of the School of Dentistry at Finis Terrae University in 2022 were collected. The data was gathered using information obtained from a data collection form.

The sample was calculated with GRANMO, using the formula for estimating a proportion. The following parameters were used for its calculation: population size of 119 canals of filled teeth (considering that each of the 119 students must undergo at least one treatment in each academic year), an acceptable proportion or prevalence of 0.7, a confidence level of 0.95 and a precision of 0.05, in addition to considering a percentage of loss of 5%. The final sample size was 92 records to be examined.

Inclusion criteria were periapical radiographs taken during endodontic treatments for which both the patient and the student had signed the informed consent form, and periapical radiographs of control endodontic treatments or retreatments of patients whose obturation was performed using the cold lateral condensation technique. Exclusion criteria were radiographs with alterations that prevented the formation of a clear image and periapical radiographs in which the radiographic apex was not observed.

Patients over 18 years of age were invited to participate in the study by means of an informed consent form delivered personally by the

investigators. A data collection form specifically designed for this study was used to record the patient's name and the academic year of the student who performed the treatment. From these data, an Excel spreadsheet was generated and delivered to the Radiology Service (RS) of the School of Dentistry. The spreadsheet had three columns in which the names of the patients were organized according to the academic year of the treating student. The RS was asked to extract the endodontic treatment control radiographs from the database (Cliniview®) in DICOM format belonging to the patients registered in the spreadsheet.

The RS was asked to sort the anonymized radiographs into folders according to the academic year associated with these radiographs. The RS provided the requested files on a digital storage device. The files were then imported into the Planmeca Romexis® Viewer program. Inclusion and exclusion criteria were applied to select the radiographs. A calibration control radiograph of the radiographic equipment was performed to verify that the equipment was calibrated and that there was a 1:1 ratio between the real image and the radiographic image.

For this purpose, a North Carolina periodontal probe was used, and an x-ray was taken in direct contact with the x-ray tube. The 1 mm probe marks were then checked to ensure that they matched the same measurement in the Planmeca Romexis® Viewer software.

Two examiners were previously calibrated by a specialist in the field to determine the obturation length of the root canal. The obturation length was calculated digitally by measuring the distance between the apical end of the endodontic filling and the radiographic apex using Planmeca Romexis® Viewer software. After the examiners individually measured each radiograph, they categorized the root canal filling length as acceptable, overfilled, and underfilled according

to the criteria of Barrieshi-Nusair *et al.*,¹⁰ in 2004.

Cohen's kappa correlation coefficient was used to determine the level of agreement between the examiners' measurements. The measure of agreement for the measurements was 1,000, i.e. perfect agreement.¹¹

Finally, the examiners recorded the length of obturation in an Excel spreadsheet with the following columns: academic year, type of tooth, location of the tooth in the oral cavity, and length of root canal obturation.

RESULTS

The final sample studied consisted of 104 radiographic records, which showed that 92 canals (88.5%) had an acceptable obturation length, 7 (6.7%) were overfilled and 5 (4.8%) were underfilled.

When the obturation length was studied according to the academic year, it was observed that in 4th year, of the 9 canals recorded, 7 (77.8%) were classified as acceptable and 2 (22.2%) were overfilled. In 5th year, of the 85 canals studied, 76 (89.4%) had an acceptable obturation length, 5 (5.9%) were overfilled, and 4 (4.7%) were underfilled. Finally, at 6th year, of the 10 canals analyzed, 9 (90%) were classified as acceptable and 1 (10%) was classified as underfilled.

According to the location in the oral cavity, of 28 canals obturated in the lower jaw, 25 (89.3%) were classified as acceptable, 1 (3.6%) as overfilled, and 2 (7.1%) as underfilled. For the upper jaw, of 76 obturated canals, 67 (88.2%) were classified as acceptable, 6 (7.9%) were found to be overfilled and 3 (3.9%) underfilled.

When observing the length of obturation according to the type of tooth, it was found that

Table 1. Length of obturation of the canals analyzed according to the Barrieshi-Nusair criteria.

	Frequency	Percentage (%)
Acceptable	92	88.5
Overfilled	7	6.7
Underfilled	5	4.8
Total	104	100

Table 2. Length of root canal obturation according to academic year.

	Acceptable (%)	Overfilled (%)	Underfilled(%)
4 th	7 (77.8)	2 (22.2)	0 (0.0)
5 th	76 (89.4)	5 (5.9)	4 (4.7)
6 th	9 (90.0)	0 (0.0)	1 (10.0)

Table 3. Root canal obturation length according to location in the oral cavity.

	Acceptable (%)	Overfilled (%)	Underfilled(%)
Lower Jaw	25 (89.3)	1 (3.6)	2 (7.1)
Upper Jaw	67 (88.2)	6 (7.9)	3 (3.9)

Table 4. Root canal obturation length according to tooth.

	Acceptable (%)	Overfilled (%)	Underfilled(%)
Incisors	25 (83.3)	3 (10.0)	2 (6.7)
Canines	10 (100.0)	0 (0.0)	0 (0.0)
Premolars	57 (89.1)	4 (6.3)	3 (4.7)

in the “incisors” group, 25 canals (83.3%) had an acceptable length, 3 (10%) were overfilled and 2 (6.7%) were underfilled.

In canines, out of 10 canals studied, 100% were classified as acceptable. Finally, in the premolar group, 57 (89.1%) had an acceptable obturation length, 4 (6.3%) were overfilled, and 3 (4.7%) were underfilled.

DISCUSSION

The results obtained are different from those observed in other publications in international literature, with clear differences when compared with previous publications and even those obtained by Barrieshi-Nusair *et al.*,¹⁰ who described a percentage of acceptable treatment lengths corresponding to 61%.

In this study, 88.5% of canals were found to have an adequate obturation length, compared to

6.7% of overfilled canals and 4.8% of underfilled canals. Contrasting these results with other data collected in Latin America, they can be positioned among those that show a higher percentage of acceptable treatments: in the research conducted by Hidalgo *et al.*,¹² at the Universidad Privada de Tacna in 2015 and 2016, out of a total of 930 canals analyzed, 70.97% of acceptable lengths were observed, while in the research conducted by Campos *et al.*,¹³ in Brazil in 2021, out of a total of 368 teeth categorized in incisor, canine and premolar groups, an average of 95.2% of acceptable lengths were found.

A comparison of our results with previous studies carried out in Germany³⁵⁻³⁶ shows similarities in the quality of the fillings. On the other hand, at national level, results similar to those of this study can be found, with 93.7% of acceptable treatments in the research carried out by Ilabaca, at the Universidad de Chile in 2011, where 286 canals were analyzed; and 83.8% in the study carried out by Maldonado-Sanhueza *et al.*,¹⁴ at the Universidad Austral, where 74 canals were studied during the year 2020.

It is not easy to explain the specific reason for the difference in these results compared to those observed in other populations, as there are a large number of variables involved that may influence the understanding, development, and performance of a procedure as complex as endodontic treatment (ET). Nevertheless, it is believed that the variables involved may include aspects such as teaching methods, apical constriction localization techniques, and the use of the electronic apex locator (EAL), root canal anatomy, and even the location of the treated tooth in the oral cavity.

Regarding the teaching methods that students receive in their undergraduate stage, there are variations depending on the curriculum of each

university. This has a direct impact on the knowledge that students have of ET and its respective practice before doing it *in vivo*, either with approaches through preclinical simulation activities, interactive videos, master classes, etc.¹⁵⁻¹⁷ It has also been shown that when endodontic treatments are guided by endodontic specialists (as is the case at the School of Dentistry at the Finis Terrae University), the results are significantly more satisfactory. For example, in a study conducted in England at the Eastman Dental Hospital (EDH), 74.7% of the canals had an acceptable filling length.¹⁸

On the other hand, when treatments are guided by general dentists and/or specialists in other fields, the results tend to be inferior, with 50% of canals showing acceptable filling length in the study by Peak *et al.*,¹⁸ at the Royal Air Force in England (RAF). However, when compared to this study, the EDH and RAF studies showed inferior results.

It is important to remember that the correct location of the apical constriction and the working length of each tooth are essential for an appropriate procedure.^{3,10,19} In the past, the Ingle method was used to locate the apex using radiographs; this method required certain characteristics to be met, calculations to be made, and measurements to be recorded using radiographs only, making the process more cumbersome, complex, and prone to error.²⁰

The use of EAL to locate the apical constriction is one of the most accurate methods currently reported in the literature²¹ compared to the use of the radiographic method, which has certain limitations, such as the superimposition of structures and seeing structures in two dimensions.²⁰ In the case of Barrieshi-Nusair *et al.*,²⁰ study, which reported 61.3% of acceptable filling lengths, ET was absolutely dependent on radiographs, whereas in this study, with 88.5% of acceptable lengths, EAL

was used for all the treatments performed.

According to Nekoofar *et al.*,²² the use of an electronic apical locator is recommended as an adjunct to the radiographic method, since in clinical practice it can accurately determine the location of the apical constriction in more than 90% of cases. In this regard, it is important to note that at the Finis Terrae University, the use of the EAL is considered a basic tool when performing endodontic treatment, which explains the favorable results obtained in this study. On the other hand, it has been observed that some international studies have used panoramic radiographs, such as the one carried out in France in 2001, which recorded 31.2% of adequate fillings in a total of 1,229 teeth,²³ when carrying out the actual analysis of the length of the root canal filling.

This radiograph is mainly indicated for the general evaluation of the dentition, to determine the behavior of pathologies such as periodontitis, odontogenic and non-odon-togenic lesions, to evaluate the position of the third molar in relation to the inferior alveolar nerve and for preliminary treatment planning, while the retroalveolar periapical radiographs used in this study have, among other indications, the diagnosis and treatment of root canals due to their high fidelity in observing the periapical area and the canals.²⁴

Panoramic radiographs have an image distortion of up to 25%^{25,26} while periapical retroalveolar radiography distorts the final image by only 5%.²⁷ Other disadvantages of panoramic radiography include the high overlap of anatomical structures, which makes it difficult to define certain critical limits for these studies.^{25,27}

Despite the obvious advantages of periapical radiographs over panoramic radiographs, the technique used to obtain periapical radiographs may vary, whether it is the bisecting angle or

parallelism technique.^{27,28} Although it is not the purpose of this study to discuss which technique is better, it has been described that the parallelism technique presents even less distortion and therefore allows better measurements.^{27,28}

In this regard, the adoption of the parallelism technique for all radiographs taken during endodontic treatments at the School of Dentistry at Finis Terrae University could significantly improve the fidelity of the image and, therefore, allow more accurate confirmation of lengths in studies similar to this one.

Finally, the importance of the root and endodontic canal anatomy at the moment of performing ET should be emphasized, as there are anatomical variations. According to Vertucci, the difficulty of accurately locating the apical constriction (AC) varies according to the root anatomy and the location of the tooth, *i.e.*, it is less complex to locate the AC in uni-radicular anterior teeth, such as incisors and canines, than in posterior teeth with a greater number of roots, such as premolars and molars; in addition, when performing the procedure as such, access to the posterior area of the dental arch is more difficult, which could lead to a greater number of treatment errors.²⁹ Although molars were not included in the present study, it should be noted that premolar anatomy can also be very complex, with variations that can make ET difficult.²⁹

This is reflected in the results, where it was observed that in the premolar group, 89.1% of the treatments were acceptable, while in the canine group, 100% of the ET had an acceptable obturation length. Although adequate obturation length has been shown to be directly related to a good prognosis in endodontic treatment, it is not the only predictive factor. It should be taken into account that, as in almost any dental treatment, clinical manifestations, postoperative,

radiographic, and evaluation in time (especially in those treatments performed on teeth with periapical lesions) will always be essential to confirm the success of the therapy.

This “*multifactorial*” nature of therapeutic success does not diminish the importance of the obturation length, as several studies⁴⁻⁹ have confirmed its importance as one of the predictors of success in ET. Since this study only analyzed the length of obturation in endodontic treatments performed at the School of Dentistry at Finis Terrae University, it is suggested that future research should analyze other factors that influence the success of ET longitudinally

(such as the presence of periapical lesions or the evolution of clinical manifestations over time), in addition to modifying the methodology for measuring the length, using the paralleling technique with positioner to standardize radiographs.

Until now, the length of root canal obturation had not been analyzed in treatments performed by undergraduate dental students at the Finis Terrae University. It was possible to observe a high percentage of compatible treatments with acceptable obturation length, a relevant issue considering the importance of this factor in the prognosis of endodontic treatment.

CONFLICT OF INTERESTS

The authors declare no conflict of interest.

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Informed consent was obtained from patient

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Lucero J: Research, methodology, data analysis, revision and editing.

Galaz A: Research, methodology, editing, original draft.

Espinoza A: Research, methodology, writing, original draft.

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