

Article

Assessment of the Findings of Tooth Resistance to Fracture after Root Canal Treatment Procedure

Jacob Yousef Al-Hashemi¹, Haitham Dakhil Mohasen², Mariam Abd Ali Zainy³

1. B.D.S., M.Sc. Biomaterials, DScD in Endodontics, Ministry of Higher Education and Scientific Research, Al-Mustansiriya University, College of Dentistry, Baghdad, Iraq
* Correspondence: jacob.alhashemi@uomustansiriyah.edu.iq
2. B.D.S. M.Sc., Conservative, Ministry of Higher Education and Scientific Research, Al-Mustansiriya University, College of Dentistry, Baghdad, Iraq
* Correspondence: dr.haithem.99@gmail.com
3. B.D.S., M.Sc. Bioimaging, Ministry of Higher Education and Scientific Research, Al-Turath University, College of Dentistry, Baghdad, Iraq
* Correspondence: Mariam.zainy@gmail.com

Abstract: Root Canal treatment is a conservative treatment aimed at preserving a functional tooth for long periods with prevention/ treatment of pulp and periapical lesions to avoid caries and maintain it in situ. The objective of our study was to assess and delineate the degree of tooth resistance to fracture following the completion of root canal treatment. 95 patients between the ages of 25 and 55 years who underwent root canal treatment through root filling were recruited. The duration of the study ranged from one year, ranged from January 14, 2022, to March 17, 2023, and patient data were collected from dental clinics in Baghdad, Iraq. In achieve of study's aim, we evaluated the intensity of pain and the level of fracture resistance of the teeth in terms of mild, moderate, and severe after the root canal treatment procedure. Our findings shown that patients with ages (25 - 35) years were the most class which, include 45 cases; males had 57 cases and females had 38 cases; smokers were 56 cases, and tooth pain was the most symptoms prevalent in the patients, which include 74 cases, molar had 40 cases, which it was most common included within tooth types and location included maxilla had 57 cases, and mandibula had 38 cases, noncaries had 38 cases while primary caries 30 cases, the success rate of root filling procedure was 94.74% and the failure rate was 5.26%, where the degree of resistance of teeth to fracture classified into mild with 3 cases, moderate with 5 cases, and severe with 2 cases. The current study indicates that root canal treatment is an essential and crucial procedure to treat patients' dental caries, provides pain relief, and achieve the overall optimal health of patients.

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1. Introduction

Endodontics is a conservative dental treatment with the goal to maintain a functional tooth through avoiding or treating damage to the pulp and surrounding tissues in order to avoid tooth caries [1, 2]. It involves three equally important phases: canal preparation, microbiological control, and filling. The initial stage in the therapeutic process is the creation of the access cavity, which plays a crucial role in eradicating pulp as well as periapical infection [3 – 5].

The initial step in endodontic treatment is the access and chamber opening, which plays an important part in determining the overall outcome of the procedure. This step primarily involves creating an opening in the crown of the tooth, allowing unrestricted access for instruments to reach the pulp chamber [6, 7]. It is necessary to ensure proper cleansing as well as disinfection for the pulp chamber and canals, removal of any organic debris within the canals, preservation of the healthy dental structure, and elimination of any infected coronal structure. Additionally, accurate localization of the canals is imperative for successful treatment [8 – 11].

Improper preparation of the access can result in errors during subsequent treatment along with, ultimately lead to treatment failure. One common error during access preparation is the removal of both decayed as well as healthy dental structures, as well as defective restorations, which weaken the coronal structure [12, 13].

Minimally invasive endodontics focuses on reducing the removal of dental hard tissues and preserving them. Dentists treating endodontic diseases must possess the knowledge and ability to work in a constrained environment within the pulp chamber [14].

These skills encompass utilizing innovative instruments and solutions for efficiently cleaning the dental system, using cutting-edge dental imaging techniques and computer software to improve the precision of root canal procedures, utilizing magnification as well as lighting for examining the pulp space and implementing new materials to enhance the long-term prognosis and preservation of natural teeth. In contemporary times, there are several variations of endodontic accesses. In this study, we will focus on two specific approaches employed in the preparation of the access: the conventional access as well as conservative endodontic approach [15 – 18].

Traditional endodontic access prioritizes a direct and unobstructed path to the root canals, which enhances the efficiency of the mechanical preparation and minimizes procedural mistakes. One concern with traditional access methods is the removal of tooth structure, which can weaken the tooth and make it more prone to fractures when under pressure. The latest development in this area is a minimalist approach to access design, which aims to preserve more of the dentin and optimize the interface between endodontic and restorative treatments [19 – 24].

2. Patients and Methods

A cross-sectional study was designed for patients who underwent root canal treatment, which included 95 patients whose ages ranged from 25 to 55 years. Patient data was collected from dental clinics stationed in Baghdad, Iraq, and the study period ranged from January 14, 2022, to March 17, 2023. The basic data included all of the demographic factors that include age, gender, smoking, symptoms, type of caries, etc., in addition to the severity of pain and its cause.

We conducted a comprehensive diagnosis of the medical and endodontic conditions of the participants who had undergone root canal treatment prior to the procedure, determined the fracture resistance of the teeth through radiographic imaging, and determined the extent of tooth material loss, which was divided into four categories: none, minor (less than one-third of the crown of the tooth), medium (more than one-third of the tooth crown), and large (one-third of the crown of the tooth), as well as the type of tooth, the location of the tooth, the degrees of tooth decay, the type of restoration, and the previous restoration. Moreover, the treatment was carried out by diagnosing the patients as well as carefully examining all the teeth, which helped in determining the appropriate operation, such as total root filling.

In addition, the patients' failure and success rates of the procedure were recorded, which greatly affect the extent of the hardness of the teeth during the follow-up period,

which lasted for one year. Also, the patient's pain scores were evaluated after treatment, which determined the severity of the pain and its effect on the participants after the root canal procedure through root filling, which ranged between 0 - 10, where zero represents no pain while 10 represents the severe degree of pain. The complication rate was determined, and the most common factors that affected tooth resistance were recorded for all patients. The degree of tooth resistance to the fracture scale was evaluated for patients after root canal treatment through the Mohs scale, which ranged from 0 to 10 and was classified as light (low level of resistance), moderate (moderate resistance to fracture), and severe (extreme resistance to fracture), where 1 represents the softest, while 10 represents the hardest. In addition, our study determined success and failure criteria, where success criteria show there is no clinical symptoms or pain as well as exists of excessive mobility and swelling, while failure criteria show happening failure of root canal treatment procedure such as there is pain, swelling, or continued tooth caries, tooth fracture, and tooth resorption.

The patient data and findings were documented utilizing SPSS version 22.0. Categorical variables are quantified by numerical values along with percentages, whereas constant variables are described by their standard deviation, mean, median, minimum, as well as maximum values. Research employing multivariable logistic regression was done. The variables were chosen using a backward stepwise selection of models' procedure, in which relevant preoperative factors were taken into account, and age and sex were included at each stage in the selection process.

3. Results

Table 1. Identify demographic and baseline characteristics of patients

Characteristics	Number of cases [n = 95]	Percentage [%]
Age		
25 – 35	45	47.37%
36 – 45	36	37.89%
46 - 55	14	14.74%
Sex		
Male	57	60.0%
Female	38	40.0%
BMI, Kg/m²		
Underweight	33	34.74%

Normal weight	24	25.26%
Overweight	22	23.16%
Obesity	16	16.84%
Smoking status		
Yes	56	58.95%
No	39	41.05%
Previously root canal		
Yes	22	23.16%
No	73	76.84%
Education status		
Primary	20	21.05%
Secondary	27	28.42%
College/university	48	50.53%
Employment status		
Yes	62	65.26%
No	33	34.74%
Income status, \$		
< 700	43	45.26%
700 - 1000	35	36.84%
> 1000	17	17.89%

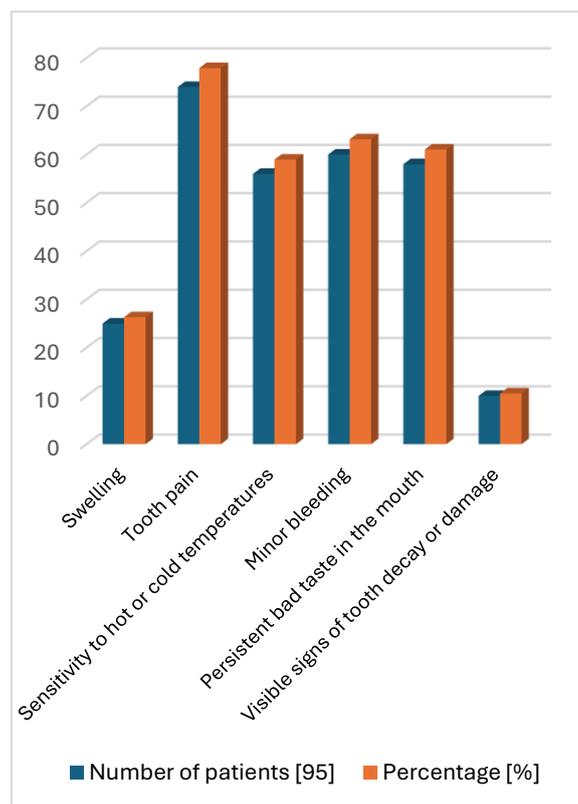
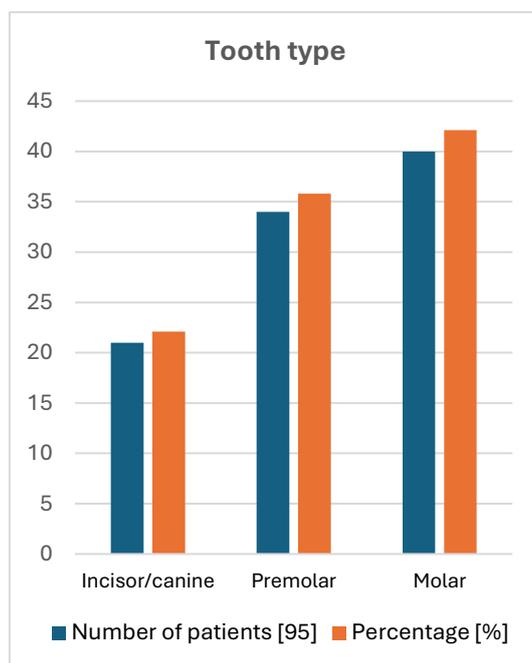
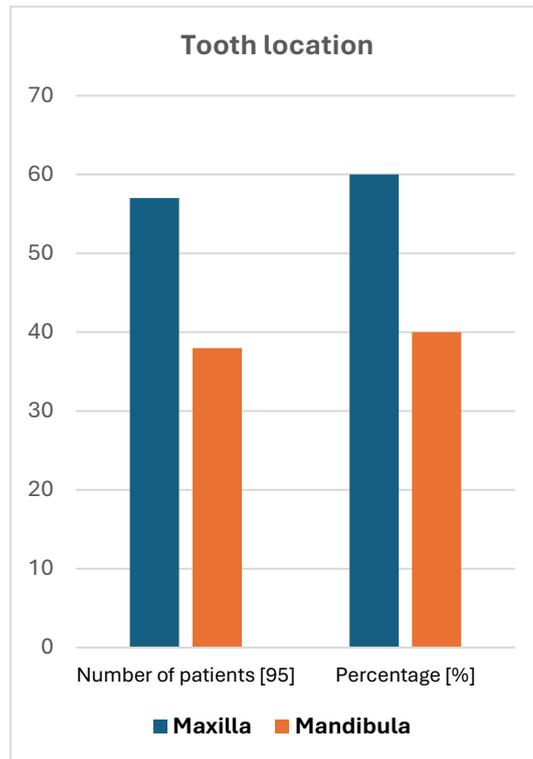


Figure 1. Enrol common symptoms prevalent in the patients

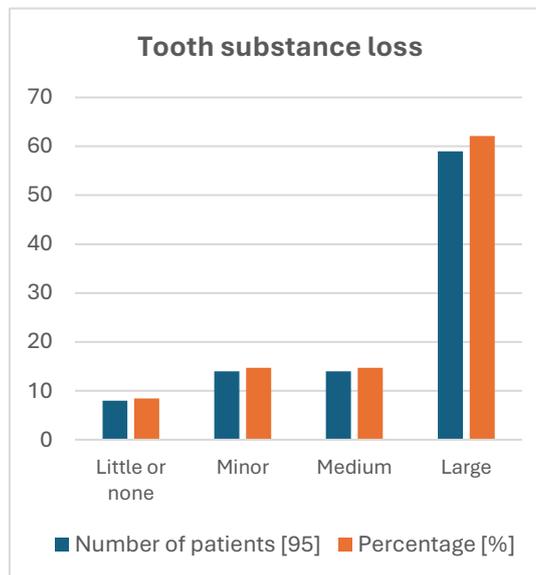
A. Tooth type



B. Tooth location



C. Tooth substance loss



D. Dental caries

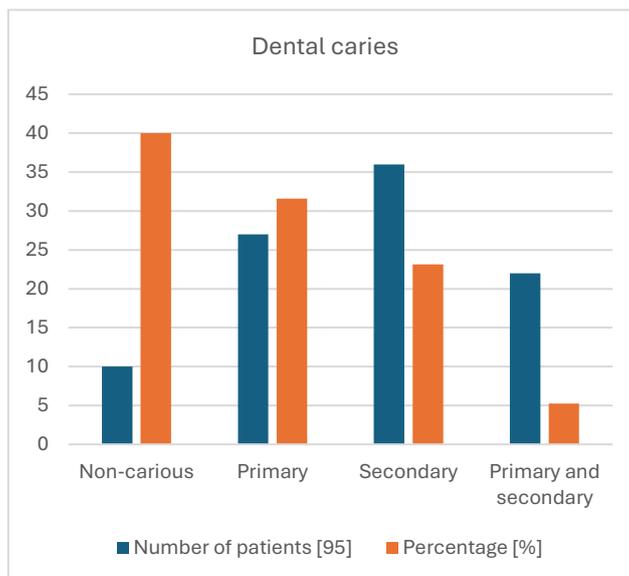


Figure 2. Distribution diagnoses findings on patients in terms of tooth type, tooth location, tooth substance loss, and dental caries

Table 2. Identify preoperative parameters related to dental caries of patients

Variables	Number of patients [95]	Percentage [%]
Previous restoration		
No restoration	8	8.42%
Direct restoration	45	47.37%
Indirect restoration	12	12.63%
Amalgam	14	14.74%
Temporary filling	16	16.84%
Number of restored surfaces		
Number of non-restored	6	6.32%
1 – 3	34	35.79%
4 - 6	55	57.89%
Pulpal and periapical diagnoses		
Previous root filling	6	6.32%
No previous root filling	72	75.79%
Vital pulp	22	23.16%
Necrotic pulp without AP	9	9.47%

Necrotic pulp with AP	31	32.63%
Other reasons	10	10.53%

Table 3. Determine the success and failure rate at patients during follow-up since conducting root canal treatment procedure

Items	Number of patients [n = 95]	Percentage [%]
Success rate	90	94.74%
Failure rate	5	5.26%

Table 4. Assessment of pain intensity for patients in comparison between before and after root canal treatment using the VAS scale

Scores	Before		After	
	N [n = 95]	P [%]	N [n =95]	P [%]
Non [0]	8	8.42%	86	90.53%
Mild [2 – 4]	14	14.74%	5	5.26%
Moderate [5 – 7]	30	31.58%	3	3.16%
Severe [8 – 10]	43	45.26%	1	1.05%

Table 5. Enrol post-operative complications affected on patients during the follow-up period

Complications	Number of cases [n = 95]	Percentage [%]
Infection	7	7.37%
Abscess formation	4	4.21%
Pain	3	3.16%
Swelling	2	2.11%

Damage to surrounding teeth	0	0.0%
Total	16	16.84%

Table 6. Assessment of degree of resistance of teeth to fracture for patients after root canal treatment by Mohs scale

Scores	Number of cases [n = 95]	Percentage [%]
Mild (lower level of resistance), [0 – 4]	3	3.16%
Moderate (moderate fracture resistance), [5-7]	5	5.26%
Severe (severe fracture resistance), [8-10]	87	91.58%

Table 7. A conducting multivariate logistic regression analysis of risk factors affected on patients who underwent root canal treatment within follow-up

Multivariate logistic regression analysis			
Variables	OR	CI 95 %	P - value
Age	2.102	1.06 – 4.54	0.104
Gender	0.86	0.55 – 2.86	0.68
Type of Tooth	1.34	0.46 – 3.92	0.60
Smoking	0.36	0.11 – 0.88	0.12
Restored surfaces	0.93	0.76 – 1.84	0.65
Dental caries	1.23	0.35 – 4.06	0.65
Pain intensity	0.73	0.40 – 2.08	0.97
Symptoms	0.81	0.31 – 5.38	0.45

4. Discussion

Our results shown that people with ages 36 – 45 years had the most class who underwent root canal treatment, which includes 36 cases, where males were 60% cases, and females were 40%, smokers were 58.95% of total cases, which it the one of the most factor lead to caries.

The most common signs or symptoms were tooth pain included 74 cases, minor bleeding included 60 cases, and persistent bad taste in the mouth included 58 cases. Molar tooth was the most prevalent type of tooth had prevalent which had 40 cases, maxilla had 57 cases, and mandibula had 38 cases, whereas dental caries were classified into non-cari-ous with 10 cases, primary with 27 cases, secondary with 36 cases, primary and secondary with 22 cases.

The current findings before the root canal treatment procedure shown 90 cases got a success rate, while 5 cases with a failure rate, 45.26% of patients had severe pain with score ranged (8 - 10), while 90.53% of patients had no pain with 0 scores, the rate of complications had 16.84% of patients, where the most factors were infection with 7 cases, the resistance of teeth to fracture classified into mild (lower level of resistance), [1 – 4] had 3 cases, moderate (moderate fracture resistance), [5 – 7] had 5 cases, and severe (severe fracture resistance), [8 – 10] had 87 cases.

The teeth are greatly affected by caries in terms of their strength, mostly due to its effect on the bond strength and mechanical integrity [25]. Research shows that caries-af-fected dentin possesses lower micro shear bond strength than sound dentin, specifically for some adhesive systems, thus posing a risk of compromising restoration quality [26].

Moreover, research has shown that microbiological and pH-cycling methods that in-duce caries led to lower micro tensile bond strength in primary teeth, which further high-lights how seriously detrimental caries can be on dentin's structural integrity [27].

This makes it much worse and emphasizes the need for early measures to help avoid them and conservative approaches like resin infiltration to restore their mechanical quali-ties and avoid fractures. Therefore, in addition to reducing their compressive strength, car-ies also increase the chances of mechanical breakdown [28].

Root canal treatment (RCT) significantly enhances tooth resistance to fracture through effective filling procedures. Teeth filled with fillings showed the highest resistance against fractures compared to other methods, which means that proper obturation can en-hance structural integrity considerably post-treatment. The role of fillings in strengthening teeth is important as evidenced in various studies on different types of materials and tech-niques used. It was found that metal granulate fillings with a bonding layer were able to provide more strength and resistance to abrasion; hence, they can be used in areas of high stress within the mouth [29 – 31].

Furthermore, the dental filling composition, especially the combination of polymer-izable monomers and inorganic fillers, has promoted improved mechanical strength and durability because smaller particles fill up gaps between bigger ones, thereby enhancing the general integrity [32]. While it is true that the filling technique has great effects on the compressive strength of the fillings, however layering and curing methods are crucial in attaining the desirable mechanical properties. Looking at some previous studies, certain filling materials, such as ones that have cotton underdressing, can lower the strength, which adds significance to the choice of materials and how we apply them to teeth. Thus, overall, if fillings will actually lead to an increase in a tooth's resistance is largely deter-mined by their composition, application method, and particular materials used [33,34].

Furthermore, it has been established that the application of fiber-reinforced compo-sites and Amalgam during restorative procedures increases their resistance to breakage more effectively than traditional materials, addressing the weaknesses caused by endo-dontic treatment [35 – 37].

5. Conclusion

Recent findings indicate that the root canal treatment procedure is highly effective in minimizing pain, preventing severe infections, and managing dental health by reducing the probability of complications or inflammation that can adversely impact other systems in the body, thereby safeguarding systemic health and sustaining overall oral well-being. In addition, we found that root canal treatment largely helps to prevent cracks, thereby making it necessary to choose the most appropriate way to restore teeth after treatment. In general, consequently, restoratives are very important in increasing the life span and resistance to wear of endodontically treated teeth, thereby controlling, in turn, risks of breakage.

REFERENCES

- [1] B. Balevi and S. Shepperd, "The Management of an Endodontically Abscessed Tooth: Patient Health State Utility, Decision-Tree and Economic Analysis," *BMC Oral Health*, vol. 7, p. 17, 2007.
- [2] L. Bjørndal and C. Reit, "The Annual Frequency of Root Fillings, Tooth Extractions and Pulp-Related Procedures in Danish Adults During 1977–2003," *International Endodontic Journal*, vol. 37, pp. 782–788, 2004. PMID: 15479261.
- [3] L. Dahlström, O. Lindwall, H. Rystedt, and C. Reit, "'Working in the Dark': Swedish General Dental Practitioners on the Complexity of Root Canal Treatment," *International Endodontic Journal*, vol. 50, pp. 636–645, 2017.
- [4] L. Dahlström, O. Lindwall, H. Rystedt, and C. Reit, "'It's Good Enough': Swedish General Dental Practitioners on Reasons for Accepting Substandard Root Filling Quality," *International Endodontic Journal*, vol. 51, no. e168–e177, 2018.
- [5] L. Dahlström, A. Molander, and C. Reit, "Introducing Nickel-Titanium Rotary Instrumentation in Public Dental Service: The Long-Term Effect on Root Filling Quality," *Oral Surgery, Oral Medicine, Oral Pathology, Oral Radiology, and Endodontology*, vol. 112, pp. 814–819, 2011.
- [6] V. S. Dawson, P. E. Isberg, T. Kvist, H. Fransson, L. Bjørndal, et al., "Further Treatments of Root-Filled Teeth in the Swedish Adult Population: A Comparison of Teeth Restored With Direct and Indirect Coronal Restorations," *Journal of Endodontics*, vol. 43, pp. 1428–1432, 2017.
- [7] N. N. Dugas, H. P. Lawrence, P. Teplitsky, and S. Friedman, "Quality of Life and Satisfaction Outcomes of Endodontic Treatment," *Journal of Endodontics*, vol. 28, pp. 819–827, 2002.
- [8] H. Fransson, L. Bjørndal, F. Frisk, V. S. Dawson, K. Landt, et al., "Factors Associated With Extraction Following Root Canal Filling in Adults," *Journal of Dental Research*, vol. 100, pp. 608–614, 2021.
- [9] H. Fransson, V. S. Dawson, F. Frisk, L. Bjørndal, EndoReCo, and T. Kvist, "Survival of Root-Filled Teeth in the Swedish Adult Population," *Journal of Endodontics*, vol. 42, pp. 216–220, 2016.
- [10] F. Frisk, A. Hugoson, and M. Hakeberg, "Technical Quality of Root Fillings and Periapical Status in Root-Filled Teeth in Jönköping, Sweden," *International Endodontic Journal*, vol. 41, pp. 958–968, 2008.
- [11] H. Göransson, T. Lougui, L. Castman, and L. Jansson, "Survival of Root-Filled Teeth in General Dentistry in a Swedish County: A 6-Year Follow-Up Study," *Acta Odontologica Scandinavica*, vol. 79, pp. 396–401, 2021.
- [12] A. A. Hamasha and A. Hatiwsh, "Quality of Life and Satisfaction of Patients After Nonsurgical Primary Root Canal Treatment Provided by Undergraduate Students, Graduate Students, and Endodontic Specialists," *International Endodontic Journal*, vol. 46, pp. 1131–1139, 2013.
- [13] J. Jonsson Sjögren, T. Kvist, A. Eliasson, and M. Pigg, "The Frequency and Characteristics of Pain and Discomfort Associated With Root-Filled Teeth: A Practice-Based Study," *International Endodontic Journal*, vol. 52, pp. 1264–1273, 2019.
- [14] S. Kebke, H. Fransson, M. Brundin, and F. J. Mota de Almeida, "Tooth Survival Following Root Canal Treatment by General Dental Practitioners in a Swedish County – A 10-Year Follow-Up Study of a Historical Cohort," *International Endodontic Journal*, vol. 54, pp. 5–14, 2021.
- [15] M. Koch, M. Englander, A. Tegelberg, and E. Wolf, "Successful Clinical and Organisational Change in Endodontic Practice: A Qualitative Study," *European Journal of Dental Education*, vol. 18, pp. 121–127, 2014.

- [16] M. Koch, E. Wolf, A. Tegelberg, and K. Petersson, "Effect of Education Intervention on the Quality and Long-Term Outcomes of Root Canal Treatment in General Practice," *International Endodontic Journal*, vol. 48, pp. 680–689, 2015.
- [17] K. Landt, L. Hagstam-Harrison, T. Kvist, F. Frisk, V. S. Dawson, et al., "Demographic Factors in Swedish Adults Undergoing Root Filling and Subsequent Extraction of a Maxillary First Molar: A Comparative Study," *International Endodontic Journal*, vol. 51, pp. 975–980, 2018.
- [18] M. Markvart, N. Tibbelin, M. Pigg, and H. Fransson, "Frequency of Additional Treatments in Relation to the Number of Roots Filled Canals in Molar Teeth in the Swedish Adult Population," *International Endodontic Journal*, vol. 54, pp. 826–833, 2021.
- [19] T. M. Marthaler, "Changes in Dental Caries 1953–2003," *Caries Research*, vol. 38, pp. 173–181, 2004.
- [20] G. A. Maryniuk and V. B. Haywood, "Placement of Cast Restorations Over Direct Pulp Capping Procedures: A Decision Analytic Approach," *Journal of the American Dental Association*, vol. 120, pp. 183–187, 1990.
- [21] A. Molander, D. Caplan, G. Bergenholtz, and C. Reit, "Improved Quality of Root Fillings Provided by General Dental Practitioners Educated in Nickel-Titanium Rotary Instrumentation," *International Endodontic Journal*, vol. 40, pp. 254–260, 2007.
- [22] M. F. Morris, T. C. Kirkpatrick, R. E. Rutledge, and W. G. Schindler, "Comparison of Nonsurgical Root Canal Treatment and Single-Tooth Implants," *Journal of Endodontics*, vol. 35, pp. 1325–1330, 2009.
- [23] Y. L. Ng, V. Mann, S. Rahbaran, J. Lewsey, and K. Gulabivala, "Outcome of Primary Root Canal Treatment: A Systematic Review of the Literature – Part 1. Effects of Study Characteristics on the Probability of Success," *International Endodontic Journal*, vol. 40, pp. 921–939, 2007.
- [24] Y. L. Ng, V. Mann, and K. Gulabivala, "Tooth Survival Following Non-Surgical Root Canal Treatment: A Systematic Review of the Literature," *International Endodontic Journal*, vol. 43, pp. 171–189, 2010.
- [25] D. R. Nixdorf, E. J. Moana-Filho, A. S. Law, L. A. McGuire, J. S. Hodges, and M. T. John, "Frequency of Persistent Tooth Pain After Root Canal Therapy: A Systematic Review and Meta-Analysis," *Journal of Endodontics*, vol. 36, pp. 224–230, 2010.
- [26] M. E. Broz, R. F. Cook, and D. L. Whitney, "Microhardness, Toughness, and Modulus of Mohs Scale Minerals," *American Mineralogist*, vol. 91, no. 1, pp. 135–142, 2006.
- [27] R. Märgärit et al., "Fracture Resistance of Molars With MOD Cavities Restored With Different Materials," 2021.
- [28] W. Geurtsen, M. Orth, and A. Gartner, "Fracture Resistance of Human Maxillary Molars With MOD Amalgam or Composite Fillings," *Deutsche Zahnärztliche Zeitschrift*, vol. 44, no. 2, pp. 108–110, 1989.
- [29] D. B. Boyer and L. Roth, "Fracture Resistance of Teeth With Bonded Amalgams," *American Journal of Dentistry*, vol. 7, no. 2, pp. 91–94, 1994.
- [30] A. Kabtoleh, O. Aljabban, and Y. A. Tolibah, "Fracture Resistance of Molars With Simulated Strip Perforation Repaired With Different Calcium Silicate-Based Cement," *Cureus*, vol. 15, no. 1, 2023.
- [31] O. A. Peters, Ed., *The Guidebook to Molar Endodontics*. Berlin, Heidelberg: Springer Berlin/Heidelberg, 2016.
- [32] C. Reit, "Decision Strategies in Endodontics: On the Design of a Recall Program," *Endodontics & Dental Traumatology*, vol. 3, pp. 233–239, 1987.
- [33] D. Simons and D. Williams, "Can Audit Improve Patient Care and Treatment Outcomes in Endodontics?," *British Dental Journal*, vol. 214, no. E25, 2013.
- [34] E. Wigsten, A. Al-Hajj, P. Jonasson, T. Kvist, and L. Bjørndal, "Patient Satisfaction With Root Canal Treatment and Outcomes in the Swedish Public Dental Health Service: A Prospective Cohort Study," *International Endodontic Journal*, vol. 00, pp. 1462–1472, 2021.
- [35] E. Wigsten, P. Jonasson, and T. Kvist, "Indications for Root Canal Treatment in a Swedish County Dental Service: Patient- and Tooth-Specific Characteristics," *International Endodontic Journal*, vol. 52, pp. 158–168, 2019.
- [36] E. Wigsten, T. Kvist, P. E. Isberg, and H. Fransson, "Comparative Analysis of General Dental Practitioners' Fees and Scheduled Fees for Root Canal Treatment and Coronal Restorations in the Adult Population of Sweden: A 5-Year Follow-Up of Data From the Swedish Dental Register," *International Endodontic Journal*, vol. 51, pp. 141–147, 2018.
- [37] E. Wigsten, T. Kvist, P. Jonasson, T. Davidson, L. Bjørndal, et al., "Comparing the Quality of Life of Patients Undergoing Root Canal Treatment or Tooth Extraction," *Journal of Endodontics*, vol. 46, pp. 19–28.e11, 2020.