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Assessment of the Impact of Root Canal Instrumentation on Fracture Resistance

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Abstract: BACKGROUND: Root canal therapy is a common treatment for patients presenting with severely carious or infected pulp tissues. The procedure effectively eliminates all inflamed and infected pulp tissues, thereby providing high healing and preventing the progression of disease and infection. This preserves the function of the tooth that was treated endodontically. **AIM:** The objective of this study is to investigate the impact of root canal treatment utilizing hand and rotary instruments on the treatment outcomes of patients. Additionally, the study aims to ascertain the extent of tooth resistance to fracture following treatment during the follow-up period. **PATIENTS AND METHODS:** This was a cross-sectional study conducted on patients with inflamed and infected pulp tissues, which include 96 cases within a follow-up, where root canal treatment was conducted on teeth by either rotary and manual instrumentations, in which all patients were monitored at post-6-month, 1-year, and 2-year periods, where tooth survival was determined during year period through assessing whether tooth was in situ in the oral cavity or extracted. Tooth Resistance to Fracture was also measured by the MOHS scale. **RESULTS:** In terms of Root canal instrumented procedure outcomes, the operative time of the rotary procedure was 97.18 ± 12.40 min, and the manual procedure was 57.18 ± 9.40; intraoperative complications in the rotary group had 4 cases, and intraoperative complications in the manual group had 6 cases. Treatment outcomes of favourable, with 95.83% of patients in the rotary group while 89.58% in the manual group. Also, 50% of patients had favourable treatment in apical periodontitis, and high recovery in pain rates was 10.42% of patients in pre-operative, 97.92% after rotary instrument procedure, and 93.75% of patients after manual instrument procedure. In the assessment of the level of resistance of teeth to fracture at patients in post - Root canal instrumented procedure, severe fracture resistance included 98.96% in patients who underwent rotary instrument procedure and 96.88% in patients who underwent manual instrument procedure. In terms of the Kaplan–Meier survival curve, this curve shown a high recovery of patients, which increases of survival probability in the long term. **CONCLUSION:** After Root Canal treatment was performed, the rotary instrumentation approach proved to be more effective than the manual instrumentation approach to solving clinical symptoms and encouraging healing around the tip of the tooth's root. However, both procedures showed successful outcomes in treating severely decayed or infected teeth, resulting in high survival rates of teeth, increased resistance to fracture, improved recovery, and less discomfort.

Keywords: Manual and Rotary instrumentations; Root Canal Treatment (RCT); Inflamed and Infected Pulp Tissues; Tooth Resistance to Fracture; and Tooth Survival.

INTRODUCTION

The World Health Organization (WHO) has indicated the prevalence of caries in primary dentition worldwide, of which a high percentage remain untreated [Zahran, S. *et al.*, 2021]. It can cause complications such as reversible pulpitis, irreversible pulpitis, and pulp necrosis [Fleming, C. H. *et al.*, 2010]. A key principle of dentistry is that therapeutic endodontic procedures in children and adolescents should contribute to maintaining temporary teeth until natural exfoliation occurs. The pulp treatments are the pulpotomy and the pulpectomy [Riis, A. *et al.*, 2018]. The Clinical Guideline of the American Association of Dental indicates that, in relation to the use of vital pulp therapies in primary dentition with deep caries lesions, the goal of treatment is to maintain pulp vitality. Pulpotomy is the process of preserving vitality in deciduous teeth. In this process, one takes out at some point any tissue from its own teeth pulp without killing them or their blood vessels [Kebke, S. *et al.*, 2021; European Society of Endodontology, 2006].

Pulpectomy is a typical endodontic method used to treat infected teeth and remove necrotic tissue. It involves the complete removal of pulp and periradicular infection. This treatment is commonly used in primary teeth, where all the tissue is removed from both the pulp chamber and root canals. Following that, the ducts are thoroughly cleaned and disinfected, and the dental organs are filled with a material that can be absorbed by the body. Finally, the tooth is restored to prevent any microfiltration and maintain an infection-free state in the mouth [Azim, A. A. *et al.*, 2016 - Vahdati, S. A. *et al.*, 2019]. It is indicated in situations whenever there is significant inflammation in the coronal pulp, and there are uncertainties about obtaining success with the conventional pulpotomy procedure [Lane, J. *et al.*, 2019].

Mondragon *et al.*, emphasize that rotary instrumentation systems in endodontics enable quicker access time to the root canal compared to

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manual approaches. Furthermore, they note that manual techniques are equally effective as rotary systems for root canal cleaning operations [Borén, D. L. *et al.*, 2015; Cheung, G. S. *et al.*, 2009]. According to these authors, rotary systems provide superior clinical effectiveness in comparison to manual procedures in several aspects, including instrumentation time, channel shaping, shorter working time, improved collaboration, and less patient weariness [Del Fabbro, M. *et al.*, 2018].

Waly, *et al*., carried out an investigation where they compared using cone beam computed tomography (CBCT), two systems of rotary files, and manual instrumentation for the preparation of the root canal with respect to the transport of the duct, the ratio of centering capacity and the thickness of the dentin [Makanjuola, J. O. *et al.*, 2018 – Varkevisser, C. M. *et al.*, 2003]. Their results showed that, although the rotary file systems reported superior successes in the preparation of the root canal compared to manual instrumentation, no significant differences were observed between the groups of their study for the transport of the duct and the thickness of the dentin [Wei, X. *et al.*, 2003].

PATIENTS AND METHODS

A cohort of patients with inflamed and infected pulp tissues, which include 96 cases and aged 30-60 years who were enrolled between March 2022 and August 2023 and who underwent root canal treatment using instruments (rotary instruments vs. manual), was included. The demographic and clinical data of the patients were collected, including age, gender, comorbidities, smoking and nutrition data, and clinical symptoms of the patients. All data of the patients were recorded, and they were diagnosed with either irreversible pulpitis, non-vital pulpitis without periapical injury, uncomplicated coronal fracture, or apical periodontitis with no more than 2 × 2 mm periapical radiolucency. As a result, dental data and their locations were established for anterior teeth or first premolars (maxillary or mandibular), which had no pain, mild pain, moderate pain, or severe pain before the operation while excluding criteria consisted of weeping-canal teeth and periapical abscess; periodontal disease associated with teeth; teeth experiencing intrinsic or extrinsic root resorption; abnormal curvature of tooth roots; and non-restorable teeth. The randomizing process was carried out by the endodontist[s]. Each and every individual meeting the inclusion criterion was assigned his or her tooth to any selected category without following any established pattern. In order to maintain objectivity and ensure equal sample sizes, patients who needed CT imaging for multiple teeth, especially those requiring two on both sides (left and right), were chosen randomly. A detailed history taking and examination, as well as electric pulp tests, tooth percussion, or radiography, were done to establish the diagnosis.

After the completion of access cavity preparation and determination of the working length, canal preparation was performed out using either the manual step-back approach with stainless steel K-files or the ProTaper Universal rotary files. This was done by employing continuous rotary instrumentation with a crown-down fashion, utilizing the X-Smart Plus endomotor. Each group received the same amount for an irrigating solution consisting of 2.5% sodium hypochlorite in a volume of 30 mL per canal. Canal lubrication was performed with RC Prep from Stone Pharmaceuticals. A 30-gauge needle with a rubber stopper length guide was put into the canal, stopping 2 mm before reaching the working length. The needle was then manipulated in an up-and-down motion during irrigation. A volume of approximately 3 mL of 17% EDTA was applied after the canal preparation to eliminate the smear layer. An X-ray was obtained immediately after the filling procedure to check for any excess filling material (gutta percha) that may have been pushed beyond the root tip. If the filling material did not completely cover the whole length of the root canal or if there were any empty spaces within the filling, the filling procedure was repeated. A single operator conducted all treatments to remove any potential bias caused by various operators.

The pain rating was collected by the Universal Pain Assessment Tool, specifically the Wong-Baker FACES Pain Rating Scale. The mobility of the tooth was assessed and categorized based on Miller's index. Periapical radiograph was utilized for radiographic examination since it is the suggested method for regular endodontic evaluation. A revised periapical index (PAI) scoring system was utilized to evaluate the presence of periapical lesions. Teeth were categorized with a periapical lesion if the PAI score was three or above. The dimensions of any radiolucency were ascertained by measuring its maximum horizontal and vertical widths using a millimeter ruler. The preoperative radiography results were compared with the radiographic data from the 2-year follow-up periods to ascertain if

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the radiolucency observed was a newly developed postoperative lesion and a preexisting lesion which maintained its size, diminished, or enlarged. The tooth's resistance to fracture was assessed in patients who had undergone root canal treatment using the Mohs scale. This scale, ranging from 0 to 10, categorized the resistance as light (low resistance), moderate (moderate resistance), or severe (high resistance). A value of 1 indicated the softest tooth, while a value of 10 indicated the hardest tooth. The patient data and conclusions were recorded using SPSS version 22.0. Categorical variables are represented by numerical values and percentages, whereas constant variables are defined through standard deviation, mean, median, minimum, and maximum values. A study utilizing multivariable logistic regression was conducted. The variables were selected by a backward stepwise model selection technique, taking into consideration significant preoperative characteristics, and included age and sex at each stage of the selection process.

RESULTS

Table 1: Enrol basic data of patients who underwent Root canal instrumented (Manual and Rotary instrumentations).

Variables	Details, 96 [%]
• Age	
- 30 – 40	36 [37.5%]
- 41 – 50	33 [34.38%]
- 51 - 60	27 [28.13%]
• Sex	
- Men	58 [60.42%]
- Women	38 [39.58%]
• Comorbidities	
Yes	62 [64.58%]
No	34 [35.42%]
- Hypertension	50 [52.08%]
- Diabetes	37 [38.54%]
- Obesity	45 [46.88%]
- Heart disease	13 [13.54%]
- Others	9 [9.38%]
• ASA	
- I	13 [13.54%]
- II	28 [29.17%]
- III	35 [36.46%]
- IV	20 [20.83%]
• Symptoms	
- Toothache	84 [87.50%]
- Sensitivity to hot or cold temperatures	74 [77.08%]
- Swelling in the gums near the affected tooth	63 [65.63%]
- Discoloration of the affected tooth	40 [41.67%]
- Bad taste in the mouth	60 [62.50%]
- Difficulty chewing or biting	20 [20.83%]
- Fever	17 [17.71%]
• Smoking	
- Smokers	54 [56.25%]
- Non – smokers	42 [43.75%]
• Education status	
- Primary	17 [17.71%]
- Secondary	28 [29.17%]
- College/university	50 [52.08%]
• Income status	
< 560	36 [37.50%]
560 - 1200	43 [44.79%]
> 1200	17 [17.71%]

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Table 2: Evaluation of the severity of periodontal disease in patients before Root canal instrumented procedure performed by Periodontal Screening and Recording (PSR) index.

Scores	Number of patients [96]	Percentage [%]
0 [Healthy gums]	0	0%
1 [Mild inflammation of the gums]	10	10.42%
2 [Mild periodontitis]	14	14.58%
3 [Moderate periodontitis]	20	20.83%
4 [Severe periodontitis]	52	54.17%

Table 3: Determine diagnostic data of patients before the Root canal instrumented procedure is performed.

Variables	Diagnoses outcomes
Tooth location	
Maxillary	64 [66.67%]
Mandibular	32 [33.33%]
Tooth type	
Anterior	52 [54.17%]
Posterior	44 [45.83%]
Severity of caries by International Caries Detection and Assessment System (ICDAS)	
0 [Sound tooth surface]	0 [0.00%]
1 [First visual change in enamel]	4 [4.17%]
2 [Distinct visual change in enamel]	13 [13.54%]
3 [Localized enamel breakdown]	17 [17.71%]
4 [Underlying dentin shadow]	20 [20.83%]
5 [Distinct cavity with visible dentin]	22 [22.92%]
6 [Extensive cavity with visible dentin]	20 [20.83%]

Table 4: Intraoperative outcomes of Root canal instrumented procedure.

Parameters	Rotary [n = 48]	Manual [n = 48]
Operative time, min	97.18 ± 12.40	57.18 ± 9.40
Local anesthesia (lidocaine and articaine)	48 [100%]	48 [100%]
Length of instruments	15 – 40	
Diameter of instruments	0.06 – 0.80	
Length of the root canal		
Filling to 0–2 mm of the radiographic apex	34 [70.83%]	30 [62.50%]
Infra/overfilling	14 [29.17%]	18 [37.5%]
Intraoperative complications		
No	44 [91.67%]	42 [87.50%]
Yes	4 [8.33%]	6 [12.50%]

Table 5: Determine patients' outcomes in terms of treatment outcome and root canal preparation procedure during follow-up.

Items	Rotary [n = 48]		Manual [n = 48]	
	N	%	N	%
Favourable	46	95.83%	43	89.58%
Uncertain	2	4.17%	5	10.42%
Unfavourable	0	0.00%	0	0%

Table 6: Determine treatment outcomes of patients after the Root canal instrumented procedure.

Parameters	Favourable, N [%]	Uncertain, N [%]	Unfavourable, N [%]
Apical periodontitis	48 [50.0%]	7 [7.29%]	0 [0%]
Uncomplicated coronal fracture	8 [8.33%]	0 [0%]	0 [0%]
Irreversible pulpitis	22 [22.92%]	0 [0%]	0 [0%]
Pulp necrosis	10 [10.42%]	1 [1.04%]	0 [0%]
Total	88 [91.67%]	8 [8.33%]	0 [0%]

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Table 7: Assessment of pain level at patients after Root canal instrumented procedure.

Items	Pre-operative		Postoperative			
			Rotary		Manual	
	N	%	N	%	N	%
0, [No pain]	10	10.42%	94	97.92%	90	93.75%
1 – 4, [Mild pain]	20	20.83%	1	1.04%	4	4.17%
5 – 7, [Moderate] pain	30	31.25%	1	1.04%	2	2.08%
8 – 10, [Severe pain]	36	37.50%	0	0.0%	0	0.0%

Table 8: Assessment level of resistance of teeth to fracture at patients in post - Root canal instrumented procedure (instrumented (Manual and Rotary instrumentations) by Mohs scale.

Items	Rotary [48]		Manual [48]	
	N	%	N	%
Mild (lower level of resistance), [0 – 4]	0	0.0%	0	0.0%
Moderate (moderate fracture resistance), [5-7]	1	1.04%	3	3.13%
Severe (severe fracture resistance), [8-10]	95	98.96%	93	96.88%

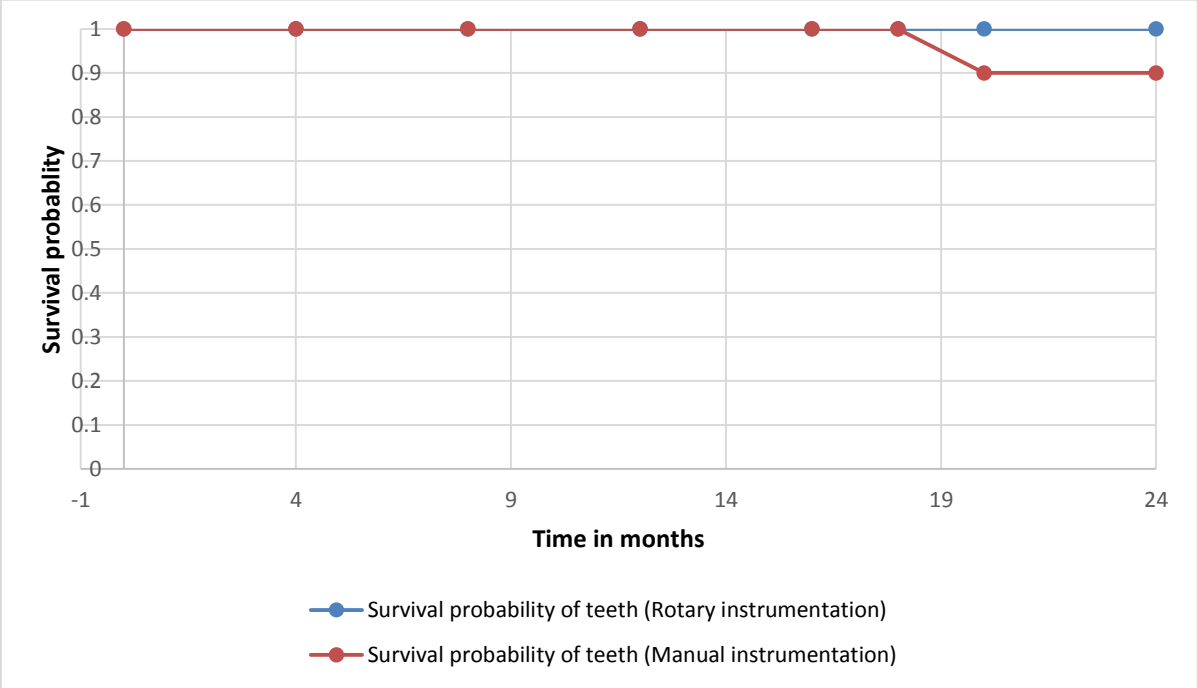

Figure 1: Kaplan–Meier survival curve.

DISCUSSION

This corroborates the findings of Molven, *et al*., who emphasized the necessity of conducting a comprehensive review lasting at least two years in order to draw definitive conclusions despite the first apparent success of randomized controlled trials (RCTs). Thus, this study employed a prolonged assessment to ascertain the effectiveness of endodontic treatment. Tooth survival is an important factor to consider in RCT since it directly impacts longevity. Tooth survival is a metric that focuses on the patient's perspective and is used to quantify the effectiveness of endodontic therapy. On the other hand, treatment outcome, which takes into account the healing of the periapical area, provides a more objective assessment of success from the clinician's point of view.

Throughout all evaluations conducted after six months and one year later, the rotary group demonstrated statistically significant ($P < .04$) better results than those obtained by the manual group. However, no significant differences ($P > .05$) were observed in terms of long-term outcomes between both groups. The turbine and hand tools presented comparable and positive results, with a high survival rate of two years. Cheung and Liu, conducting retrospective research, have revealed that rotary root canal therapy (RCT) has a better incidence of short-term favorable outcomes as compared to manual RCT. The improved success

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rate seen in the rotary group may be attributed to there being less apical debris extrusion thus facilitating faster healing processes within the periapical region [Aminoshariae, A. *et al.*, 2020].

Drilling by hand instrument can release debris from the apex, resulting in a situation where blood and exudates may flow into it. Consequently, intracanal microorganisms may proliferate thus making the chronic periapical lesion worse. In this respect, our study results are similar to those obtained from another retrospective study carried out by Fleming, *et al*., who found that both groups had a comparable 2-year survival rate based on tooth preservation. Moreover, they took into account tooth longevity as a criterion for success in both methods and did follow-up over a long time.

The ultimate transient clinical trial reached total alleviation of pain, which was stated as the absence of pain mistakenly during the early proceed of this study. However, at their 2-year assessment period, two patients from each group reported moderate pain, which had resolved by the time of the final assessment. This mild discomfort could be due to periodontal reasons or occlusal trauma, of which the patient had forgotten during evaluation. They do not relate with past issues regarding tooth pulp or its adjacent tissues [Molander, A. *et al.*, 2007; Huumonen, S. *et al.*, 2013].

Both groups experienced complete resolution of tooth soreness at the 6-month follow-up. However, two teeth, one for each group, were found to have soreness at the 2-year evaluation, and only two teeth in the manual group had discomfort during the final evaluation. These patients displayed plaque accumulation around the edges of the dental restorations and periodontal pockets with depths ranging from 4 to 5 mm. Therefore, it is probable that the tooth soreness experienced by these individuals was caused by periodontal factors [Molven, O. *et al.*, 2002; Siqueira, J. F. *et al.*, 2003].

The presence of apical periodontitis in over 45% of patients for each group before root canal treatment (RCT) supports the reason for the considerable disparity in periapical healing observed for both groups throughout the intermediate evaluations. Cheung and Liu also observed a notable improvement in periapical healing while utilizing rotational instruments, as seen by their short-term monitoring. Our investigation found that both groups had similar healing rates under long-term monitoring. The study demonstrates that the effectiveness of endodontic treatment, as shown by a high incidence of tooth retention as well as positive results, is heavily reliant on the ability and knowledge of the operator. Cheung and Liu showed this phenomenon, showing that randomized controlled trials (RCTs) conducted by postgraduate students showed markedly better rates of success in comparison to those conducted by undergraduates [Mittal, R. *et al.*, 2015].

The 2-year success rate for both groups is higher compared to the considerably superior outcome reported by the rotary group within the short-term evaluation period (6-month and 1-year post-treatment). The observed phenomenon can be attributed to the typical ongoing remission of pain, edema, and periapical disease that occurs after a successful root canal treatment [Kalra, P. *et al.*, 2017].

CONCLUSION

This present study indicated the effectiveness of the rotary instrumentation technique in promoting healing in shorter periods compared to the manual instrumentation technique. However, both techniques showed a significant effect on patients in terms of promoting healing, improving tooth survival rates and higher tooth fracture resistance in all patients who underwent root canal treatment.

REFERENCES

1. Zahran, S., Patel, S., Koller, G. & Mannocci, F. "The impact of an enhanced infection control protocol on molar root canal treatment outcome–a randomized clinical trial." *International Endodontic Journal*, 54 (2021): 1993–2005.
2. Fleming, C. H., Litaker, M. S., Alley, L. W. & Eleazer, P. D. "Comparison of classic endodontic techniques versus contemporary techniques on endodontic treatment success." *Journal of Endodontics*, 36 (2010): 414–418.
3. Riis, A., Taschieri, S., Del Fabbro, M. & Kvist, T. "Tooth survival after surgical or nonsurgical endodontic retreatment: long-term follow-up of a randomized clinical trial." *Journal of Endodontics*, 44 (2018): 1480–1486.
4. Kebke, S., Fransson, H., Brundin, M. & Mota de Almeida, F. J. "Tooth survival following root canal treatment by general dental practitioners in a Swedish county–a 10-year follow-up study of a historical cohort."

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International Endodontic Journal, 54 (2021): 5–14.
5. European Society of Endodontology. "Quality guidelines for endodontic treatment: consensus report of the European Society of Endodontology." *International Endodontic Journal*, 39 (2006): 921–930.
6. Azim, A. A., Griggs, J. A. & Huang, G. J. "The Tennessee study: factors affecting treatment outcome and healing time following nonsurgical root canal treatment." *International Endodontic Journal*, 49 (2016): 6–16.
7. Estrela, C., Holland, R., Estrela, C. R., et al. "Characterization of successful root canal treatment." *Brazilian Dental Journal*, 25 (2014): 3–11.
8. Chatzopoulos, G. S., Koidou, V. P., Lunos, S. & Wolff, L. F. "Implant and root canal treatment: survival rates and factors associated with treatment outcome." *Journal of Dentistry*, 71 (2018): 61–66.
9. Vahdati, S. A., Torabinejad, M., Handysides, R. & Lozada, J. "A retrospective comparison of outcome in patients who received both nonsurgical root canal treatment and single-tooth implants." *Journal of Endodontics*, 45 (2019): 99–103.
10. Lane, J. & Bonsor, S. "Survival rates of teeth treated with bacterial photo-dynamic therapy during disinfection of the root canal system." *British Dental Journal*, 226 (2019): 333–339.
11. Borén, D. L., Jonasson, P. & Kvist, T. "Long-term survival of endodontically treated teeth at a public dental specialist clinic." *Journal of Endodontics*, 41 (2015): 176–181.
12. Cheung, G. S. & Liu, C. S. "A retrospective study of endodontic treatment outcome between nickel-titanium rotary and stainless-steel hand filing techniques." *Journal of Endodontics*, 35 (2009): 938–943.
13. Del Fabbro, M., Afrashtehfar, K. I., Corbella, S., El-Kabbaney, A., Perondi, I. & Taschieri, S. "In vivo and in vitro effectiveness of rotary nickel-titanium vs manual stainless-steel instruments for root canal therapy: systematic review and meta-analysis." *Journal of Evidence-Based Dental Practice*, 18 (2018): 59–69.
14. Makanjuola, J. O., Umesi, D. C. & Oderinu, O. H. "Treatment outcome in rotary versus manual techniques in single-visit endodontics." *Journal of West African College of Surgeons*, 8 (2018): 44–75.
15. Patil, A. A., Joshi, S. B., Bhagwat, S. V. & Patil, S. A. "Incidence of postoperative pain after a single visit and two visit root canal therapy: a randomized controlled trial." *Journal of Clinical and Diagnostic Research*, 10 (2016): 9–12.
16. Mayhew, D., Mendonca, V. & Murthy, B. V. S. "A review of ASA physical status – historical perspectives and modern developments." *Anaesthesia*, 74 (2019): 373–379.
17. Varkevisser, C. M., Pathmanathan, I. & Brownlee, A. "Designing and conducting health systems research projects, volume 1, proposal development and fieldwork." *International Development Research Centre*, Amsterdam (2003): 216.
18. Wei, X. & Lin, S. P. "The effect of root canal preparation with nickel-titanium rotary instruments in reducing post-operative pain." *West China Journal of Stomatology*, 21 (2003): 202–204.
19. Wong, D. L., Hockenberry-Easton, M., Wilson, D., Winkelstein, M. L. & Schwartz, P. *Wong's Essentials of Paediatric Nursing.* 6th ed., Mosby Elsevier, St Louis (2001): 1301.
20. Aminoshariae, A., Mackey, S. A., Palomo, L. & Kulild, J. C. "Declassifying mobility classification." *Journal of Endodontics*, 46 (2020): 1539–1544.
21. Fayad, M. I., Nair, M., Levin, M. D., et al. "AAE and AAOMR joint position statement: use of cone beam computed tomography in endodontics 2015 update." *Oral Surgery, Oral Medicine, Oral Pathology, Oral Radiology*, 120 (2015): 508–512.
22. Molander, A., Warfvinge, J., Reit, C. & Kvist, T. "Clinical and radiographic evaluation of one-and two-visit endodontic treatment of asymptomatic necrotic teeth with apical periodontitis: a randomized clinical trial." *Journal of Endodontics*, 33 (2007): 1145–1148.
23. Huumonen, S. & Ørstavik, D. "Radiographic follow-up of periapical status after endodontic treatment of teeth with and without apical periodontitis." *Clinical Oral Investigations*, 17 (2013): 2099–2104.
24. Molven, O., Halse, A., Fristad, I. & MacDonald-Jankowski, D. "Periapical changes following root-canal treatment observed 20-27 years postoperatively." *International Endodontic Journal*, 35 (2002): 784–790.

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25. Siqueira, J. F., Jr. "Microbial causes of endodontic flare-ups." *International Endodontic Journal*, 36 (2003): 453–463.
26. Mittal, R., Singla, M. G., Garg, A. & Dhawan, A. "A comparison of apical bacterial extrusion in the manual, ProTaper rotary, and one-shape rotary instrumentation techniques." Journal of Endodontics, 41 (2015): 2040–2044.
27. Kalra, P., Rao, A., Suman, E., Shenoy, R. & Suprabha, B. S. "Evaluation of conventional, protaper hand and protaper rotary instrumentation system for apical extrusion of debris, irrigants, and bacteria-an in vitro randomized trial." Journal of Clinical and Experimental Dentistry, 9 (2017): e254–e258.

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