

## Research Report

## Endodontic flare-up incidence in irreversible pulpitis in Universitas Airlangga Dental Hospital (RSKGMP Universitas Airlangga)

Galih Sampoerno<sup>1</sup>, Sukaton<sup>1</sup>, Salwa Aulia Rahmawati<sup>2</sup>, Jennifer Fiona Salim<sup>2</sup>

<sup>1</sup>Departement of Conservative Dentistry, Faculty of Dental Medicine, Universitas Airlangga, Surabaya, Indonesia

<sup>2</sup>Dentist Education Student, Faculty of Dental Medicine, Universitas Airlangga, Surabaya, Indonesia

### ABSTRACT

**Background:** Carious lesions that do not be treated, becomes infected and inflamed, leading to irreversible pulpitis. One of the treatments for irreversible pulpitis is root canal treatment. In root canal treatment can cause flare-ups.

**Purpose:** Obtaining a data base on flare-ups with a diagnosis of irreversible pulpitis at RSKGMP and obtaining a picture of flare-ups in irreversible pulpitis based on root canal preparation techniques, root canal irrigation materials, root canal dressing materials, and root canal obturation techniques. **Methods:** The study used was a descriptive observational study with a study design cross sectional in patients with a diagnosis of irreversible pulpitis who had received root canal treatment at the UPF Dental Conservation RSKGMP University of Airlangga in 2018, 2019, and 2020. **Results:** A total of 14 patients (28%) of 50 patients experienced (flare-up). **Conclusion:** The incidence flare-ups of root canal treatment in irreversible pulpitis at RSKGMP University of Airlangga is 28%.

**Keywords:** Flare-up, Endodontic treatment, Irreversible pulpitis, Dental Health

Correspondence: Galih Sampoerno, Department of Conservative Dentistry, Faculty of Dental Medicine, Universitas Airlangga. Jl Mayjend Prof. Dr. Moestopo no. 47, Surabaya 60132, Indonesia. E-mail: galih-s@fkg.unair.ac.id

### INTRODUCTION

Dental and oral health is still an important problem in Indonesia. Caries is one of the most common dental and oral disorders experienced by the Indonesian population. Based on the results of the Basic Health Research (Riskesdas) in 2018, the prevalence of dental caries in Indonesia in 2018 was still relatively high, at 45.3% of the total population in Indonesia. Figures 54% cavities occur in children aged 5-9 years.<sup>1</sup>

Caries is an infectious and communicable disease whose emergence and development process is influenced by various factors (multifactorial). The etiology of caries includes the host, agent, environment, and time.<sup>2</sup> When a carious lesion progresses without repair treatment, the pulp tissue becomes increasingly infected and inflamed, thereby causing dental pulp inflammation or pulpitis.<sup>3</sup> Pulp disease is divided into reversible pulpitis, irreversible pulpitis, pulp degeneration, and pulp necrosis.<sup>4</sup>

Irreversible pulpitis is a chronic inflammatory condition of the pulp, symptomatic or asymptomatic as a result of toxic irritation.<sup>4</sup> Root canal or endodontic treatment of adult permanent teeth with irreversible pulpitis is urgently needed, this is because the inflamed vital pulp cannot be healed.<sup>5</sup> Root canal treatment also involves the total removal of pulp tissue from the root canal, disinfection, and restoration with materials bioinert.<sup>6</sup>

Root canal or endodontic treatment is a treatment procedure used to treat inflammation of the pulp and necrotic tissue of the pulp caused by caries or trauma to the tooth. Teeth that have received endodontic treatment require clinical and radiographic evaluation to support the success of root canal treatment. However, in some cases, endodontic treatment can cause pain and swelling after endodontic treatment which is called a flare-up.<sup>7</sup>

Flare-up is pain that occurs as a result of endodontic treatment that occurs in a short time and within hours or days.<sup>8</sup> The cause of flare-ups is the presence of microbial factors, mechanical and chemical mediators.<sup>9</sup> Flare-ups can be caused by many factors which are a result of root canal preparation techniques, root materials dressing canal irrigants, root canal, and also root canal obturation techniques. According to research by Shahi et al.<sup>10</sup> and Makanjoula et al.<sup>11</sup>, it was shown that the frequency of flare-ups was higher in manual preparation techniques compared to rotary preparation techniques because periapical debris extrusion often occurs in manual techniques. Flare-ups can also occur due to root canal irrigating material, namely sodium hypochlorite (NaOCl), if at the time of application of NaOCl and then the NaOCl solution comes out of the root apex of the tooth, it can cause severe pain and swell.<sup>12</sup> Flare-ups can also be caused by material, dressing root canal namely calcium hydroxide (Ca(OH)<sub>2</sub>). Ca(OH)<sub>2</sub> has limited effectiveness to eliminate endodontic pathogenic bacteria,

such as *Enterococcus faecalis* and species *Candida* that cause various occurrences of recurrent infections or flare-ups.<sup>13</sup> Another factor that cause further flare-ups is the root canal obturation technique.

The incidence of flare-ups is still relatively low.<sup>14</sup> According to the research of Onay et al, The incidence of flare-ups was 59 (3.2%) of 1819 teeth of 1410 patients undergoing endodontic treatment.<sup>14</sup> A retrospective study conducted by Nair et al showed that 2% of the total 1,725 cases of endodontic treatment-experienced flare-ups.<sup>15</sup> Based on the study of Alshehri et al, the incidence of flare-ups was 16 (3.5%) out of 454 teeth undergoing endodontic treatment.<sup>16</sup> A prospective study conducted by the Department of Endodontics of Saint Joseph Beirut University in Lebanon from June 2018 to January 2019 showed that 1.9% of 423 patients had flare-ups.<sup>17</sup> According to research conducted by Aoun et al.<sup>18</sup> and Vieyra et al.<sup>19</sup>, the highest incidence of flare-ups is within 24 hours after root canal treatment. Based on these data, it shows that there is still pain or flare-ups after root canal treatment which should not occur.

Based on this background, the authors are interested in explaining the incidence of flare-ups in endodontic treatment patients with pulpitis irreversible based on the duration of time, which is 24 hours after root canal treatment at the Dental and Oral Hospital (RSKGMP) University of Airlangga. The purpose of this study was to obtain a flare-up data base with a diagnosis of irreversible pulpitis at RSKGMP and to obtain an overview of flare-ups in irreversible pulpitis based on root canal preparation techniques, root canal irrigation materials, root canal dressing materials, and root canal obturation techniques.

**MATERIALS AND METHODS**

The type of research used is descriptive observational research with a cross-sectional research design with the research variable in the form of flare-ups. The sample used in this study were patients who underwent root canal treatment at UPF Dental Conservacy RSKGMP University of Airlangga in the period from 2018 to 2020. The characteristics of the samples used in this study included: 1) Male and female; 2) Patients aged 15-65 years; 3) Has received root canal treatment with a diagnosis of irreversible pulpitis; 4) Sign the informed consent and fill out the questionnaire; and 5) patients with flare-ups at 24 hours. The sample size needed in this study was calculated using the Lemeshow 1990 formula, and the results of the calculation of the minimum sample were 49 people, so that in this study, the sample size was 50 people.

Data was collected through questionnaire interviews given to 50 respondents containing informed consent and questions related to flare-ups in irreversible pulpitis within 24 hours. The data that has been obtained is then given an assessment and calculation of scores and the results of interview data, data processing is carried out using descriptive statistical tests.

**RESULTS**

Based on the research that has been conducted on the respondents, the data obtained from the research results are as written in the Table 1. The data were obtained from the results of filling out a questionnaire that had been filled out by the respondents to determine the incidence of flare-ups of root canal treatment in irreversible pulpitis at RSKGMP University of Airlangga. Respondents in this study were patients who visited UPF Dental Conservation Airlangga University and had undergone endodontic treatment and received a diagnosis of irreversible pulpitis in the period from 2018 to 2020. Based on the calculation of the number of samples, a total of 50 respondents were taken through patient status card data that met the predetermined sample criteria. Based on the results of the study, the age group of 31-40 years is the age group that is often found coming to UPF Dental Conservation RSKGMP University of Airlangga to perform root canal treatment with a diagnosis of irreversible pulpitis.

The incidence of flare-ups was measured using a questionnaire related to pain after root canal treatment (flare-up) in irreversible pulpitis as follows:

Based on the results of the Table 2, it is known that as many as 14 respondents (28%) experienced pain after root canal treatment (flare-up) with a diagnosis of irreversible pulpitis within 24 hours after treatment, while 36 respondents (72%) did not experienced pain after root canal treatment (flare-up) with a diagnosis of irreversible pulpitis within 24 hours.

**Table 1.** Distribution of respondents by gender and age at UPF Dental Conservation RSKGMP University of Airlangga for the 2018-2020 period.

Characteristics	Total (N)	Percentage (%)
Gender		
Female	34	68%
Male	16	32%
Total	50	100%
Age		
15-20 years	10	20%
21-30 years	9	18%
31-40 years	16	32%
41-50 years	6	12%
51-60 years	6	12%
> 60 years	3	6%
Total	50	100%

**Table 2.** Distribution of respondents answers to the questionnaire flare-up for root canal treatment in irreversible pulpitis at RSKGMP University of Airlangga.

Questions	N	%
Was there any pain after root canal treatment within 24 hours?		
Yes	14	28%
No	36	72%
Total	50	100%

From the results of the Table 3, it can be seen that as many as 14 patients experienced flare-ups, 5 patients (35.71%) were male and 9 patients (64.29%) were female. Then as many as 5 patients (35.71%) aged 16-20 years, 2 patients (14.29%) aged 21-30 years, 3 patients (21.43%) aged 31-40 years, 3 patients (21.43%) aged 51-60 years, and 1 patient (7.14%) aged more than 60 years. It is also known that the number of patients who experienced flare-ups who came to UPF Dental Conservation RSKGMP Universitas Airlangga with one visit was 4 patients (28.57%) and multiple visits were 10 patients (71.43%).

From the results of the Table 4, it can be seen that flare-ups can occur due to the root canal preparation technique when performing root canal treatment for irreversible pulpitis is known that as many as 14 patients (100%) of flare-ups occurred due to the Crown Down Pressure-less

**Table 3.** Distribution of the incidence of flare-ups patient by gender, age, and the number of patient visits for irreversible pulpitis at UPF Dental Conservation RSKGMP University of Airlangga.

The incidence of flare-up	Number (N)	Percentage (%)
Gender		
Male	5	35.71%
Female	9	64.29%
Total	14	100%
Age		
Age 16-20 years	5	35.71%
Age 21-30 years	2	14.29%
Age 31-40 years	3	21.43%
Age 51 -60 years	3	21.43%
Age > 60 years	1	7.14%
Total	14	100%
Patient Visits		
One Visit	4	28.57%
Multiple Visit	10	71.43%
Total	14	100%

**Table 4.** Distribution incidence of flare-ups patient based on root canal preparation technique indicators when performing root canal treatment for irreversible pulpitis at UPF Dental Conservation RSKGMP University of Airlangga.

Indicators Flare-ups	N	%
Root canal preparation technique		
Crown Down Pressure-less	14	100%
Gender		
Male	5	35.71%
Female	9	64.29%
Total	14	100%
Age		
Age 16-20 years	5	35.71%
Age 21-30 years	2	14.29%
Age 31-40 years	3	21.43%
Age 51-60 years	3	21.43%
Age > 60 years	1	7.14%
Total	14	100%
Patient Visits		
One Visit	4	28.57%
Multiple Visit	10	71.43%
Total	14	100%

preparation technique with a distribution of 5 patients (35.71%) were male and 9 patients (64.29%) were female. Then as many as 5 patients (35.71%) aged 16-20 years, 2 patients (14.29%) aged 21-30 years, 3 patients (21.43%) aged 31-40 years, 3 patients (21.43%) aged 51-60 years, and 1 patient (7.14%) aged more than 60 years. Then as many as 4 patients (28.57%) came with one visit and 10 patients (71.43%) came with multiple visit.

From the Table 5, it is known that as many as 12 patients experienced flare-ups due to this irrigation material with a distribution of 5 patients (41.67%) were male, and 7 patients (58.33%) were female. Then as many as 5 patients (41.67%) aged 16-20 years, 1 patient (8.33%) aged 21-30 years, 3 patients (25%) aged 31-40 years, and 3 patients (25%) aged 51-60 years. Then as many as 3 patients (25%) came with one visit and 9 patients (75%) came with multiple visits.

**Table 5.** Distribution incidence of flare-up patient based on root canal indicator NaOCl + EDTA when performing root canal treatment for irreversible pulpitis irrigant UPF Dental Conservation RSKGMP University of Airlangga.

Indicators Flare-ups	N	%
Root canal irrigation materials		
NaOCl + EDTA	12	100%
Gender		
Male	5	41.67%
Female	7	58.33%
Total	12	100%
Age		
Age 16-20 years	5	41.67%
Age 21 -30 years	1	8.33%
Age 31-40 years	3	25%
Age 51-60 years	3	25%
Total	12	100%
Patient Visits		
One Visit	3	25%
Multiple Visit	9	75%
Total	12	100%

**Table 6.** Distribution of the incidence of flare-ups patient based on the indicator of root canal irrigation material NaOCl 2.5% when performing root canal treatment for irreversible pulpitis at UPF Dental Conservation RSKGMP University of Airlangga.

Indicator Flare-up	Total (N)	Percentage (%)
Root Canal Irrigation Material		
NaOCl 2.5%	1	100%
Gender		
Female	1	100%
Total	1	100%
Age		
> 60 years	1	100%
Total	1	100%
Patient visits		
Multiple visits	1	100%
Total	1	100%

From the Table 6, it can be seen as many as 1 female patient aged over 60 years with multiple visit (100%) experienced flare-ups due to this irrigation material. Also from the Table 7, it can be seen as many as 1 female patient aged 21-30 years with one visit (100%) experienced flare-ups due to this irrigation material.

From the Table 8, it is known that 14 patients (100%) experienced flare-ups due to this dressing material with a distribution of 5 patients (35.71%) were male, and 9 patients (64.29%) were female. Then as many 5 patients (35.71%) aged 16-20 years, 2 patients (14.29%) aged 21-30 years, 3 patients (21.43%) aged 31-40 years, 3 patients (21.43%) aged 51-60 years, and 1 patient (7.14%) aged more than 60 years. Then as many as 4 patients (28.57%) came with one visit and 10 patients (71.43%) came with multiple visit.

From the results of the Table 9, it can be seen that flare-ups can occur due to the single cone obturation technique. It is known that 14 patients experienced flare-ups due to this obturation technique with a distribution of 5 patients

(35.71%) were male, and 9 patients (64.29%) were female. Then as many 5 patients (35.71%) aged 16-20 years, 2 patients (14.29%) aged 21-30 years, 3 patients (21.43%) aged 31-40 years, 3 patients (21.43%) aged 51-60 years, and 1 patient (7.14%) aged more than 60 years. Then as many as 4 patients (28.57%) came with one visit and 10 patients (71.43%) came with multiple visit.

## DISCUSSION

In general, flare-ups are pain after root canal treatment that occurs in a relatively short time and within hours or days.<sup>9</sup> Based on the data that has been obtained from the results of filling out the questionnaire that has been filled out by 50 respondents, 34 respondents (68%) are female, and 16 respondents (32%) are male. From the data obtained 10 respondents (20%) aged 15–20 years, 9 respondents (18%) aged 21–30 years, 16 respondents (32%) aged 31–40 years, 6 respondents (12%) aged 41–50 years, 6 respondents (12%) were 51–60 years old and 3 respondents (6%) were over 60 years old.

The incidence of flare-ups was measured by interviewing the patient and then the patient was instructed to fill out a questionnaire about pain after root canal treatment with a diagnosis of irreversible pulpitis within 24 hours. From the results of this study, 14 respondents (28%) experienced pain after root canal treatment (flare-up) and 36 respondents (72%) did not experience pain after root canal treatment (flare-up) within 24 hours after treatment. The results of the data research showed that the number of respondents who experienced flare-ups who came to the Dental Conservation UPF, RSKGMP Universitas Airlangga with one visit (one visit) was 4 people (28.57%), while the number of patients who experienced flare-ups with several times visits (multiple visits) as many as 10 people (71.43%). This shows

**Table 7.** Incidence distribution of flare-ups patient based on root canal indicators NaOCl 2.5% + EDTA 17% when performing root canal treatment for irreversible pulpitis irrigant UPF Dental Conservation RSKGMP University of Airlangga.

Indicator Flare-up	Total (N)	Percentage (%)
Root Canal Irrigation Material		
NaOCl 2.5% + EDTA 17%	1	100%
Gender		
Female	1	100%
Total	1	100%
Age		
21-30 years	1	100%
Total	1	100%
Patient visits		
One visit	1	100%
Total	1	100%

**Table 8.** Distribution of the incidence of flare-ups patient based on indicators of material dressing root canal Calcium Hydroxide (Ca(OH)<sub>2</sub>) when performing root canal treatment for irreversible pulpitis at UPF Dental Conservation RSKGMP University of Airlangga.

Indicator Flare-up	N	%
Material Dressing Root Canal		
Calcium Hydroxide (Ca(OH) <sub>2</sub> )	14	100%
Gender		
Male	5	35.71%
Female	9	64.29%
Total	14	100%
Age		
Age 16-20 years old	5	35.71%
21-30 years old	2	14.29%
31-40 years old	3	21.43%
51-60 years old	3	21.43%
> 60 years old	1	7.14%
Total	14	100%
Patient Visits		
One Visit	4	28.57%
Multiple Visit	10	71.43%
Total	14	100%

**Table 9.** Distribution of the incidence of flare-ups of patients based on indicators of root canal obturation technique single cone when performing root canal treatment for irreversible pulpitis at UPF Dental Conservation RSKGMP University of Airlangga.

Indicators Flare-ups	N	%
Mechanical Obturation Root canal		
Single Cone	14	100%
Gender		
Male	5	35.71%
Female	9	64.29%
Total	14	100%
Age		
Age 16-20 years	5	35.71%
Age 21- 30 years old	2	14.29%
31-40 years old	3	21.43%
51-60 years old	3	21.43%
> 60 years old	1	7.14%
Total	14	100%
Patient Visits		
One Visit	4	28.57%
Multiple Visit	10	71.43%
Total	14	100%

that there is still an incidence of *flare-ups* in root canal treatment patients at UPF Dental Conservation RSKGMP Universitas Airlangga.

In general, age cannot be an indicator of flare-ups in root canal treatment. Several studies reported that age had no significant effect on the frequency of flare-ups.<sup>14</sup> However, in general, flare-ups are more common in the elderly age group, namely 40-60 years. This may be related to age-related physiological changes in humoral and cellular immunity.<sup>4</sup> However, according to the study by El Mubarak et al,<sup>20</sup> flare-ups were more common in patients aged 18-33 years. Flare-ups can also be related to gender. A longitudinal study conducted to measure the prevalence of post-obturation pain in patients undergoing root canal treatment reported that female patients tend to experience flare-ups at a higher rate than males. This can be associated with susceptibility to emotional disorders in women, such as anxiety, fear, and stress. Fluctuations in female hormone levels can also cause an increase in the hormones serotonin and noradrenaline which results in an increase in the frequency of pain during menstruation and also in women receiving hormone replacement therapy or oral contraceptives.<sup>14,16</sup> The comparison of the number of patient visits to the clinic, either one visit (one visit) or several visits (multiple visits) cannot be a benchmark for the occurrence of flare-ups. According to research by Singh et al.<sup>8</sup> it is said that the flare-up rate at multiple visits is higher than that at one visit. According to Shahi et al.<sup>10</sup>, pain after root canal treatment (flare-up) is the result of several factors, namely root canal preparation techniques, root canal irrigation materials, root canal dressing materials, and root canal obturation techniques. The data results in the following table illustrate the relationship between the incidence of flare-ups with several indicators when performing root canal treatment in irreversible pulpitis.

The results of the research data (Table 4) show that as many as 14 patients experienced flare-ups as a result of the root canal preparation technique, namely the Crown Down Pressure-less preparation technique. In general, this preparation technique causes less periapical extrusion of debris than manual preparation techniques using the step-back technique. Several studies have also shown that the Crown Down Pressure-less preparation technique causes fewer flare-ups than the manual instrument preparation technique.<sup>21</sup> This is in sync with the research of Makanjoula et al.<sup>11</sup> which concluded that the incidence of flare-ups in the Crown Down Pressure-less technique was 11.7% and the step-back technique was 16.7%. However, flare-ups can occur with the Crown Down Pressure-less preparation technique. This happens if there is an error in determining the working length during root canal treatment. Working length Improper due to overestimation of the operator can lead to over-instrumentation which results in the extrusion of debris and root canal filling material in the periapical tissue which can cause irritation and flare-ups. Yuanita's research proved that root canal preparation using step-back and crown-down pressureless technique can cause a number

of debris to be removed from the tooth apex during root canal preparation or instrumentation.<sup>14</sup>

In general, NaOCl is an irrigating agent that can dissolve necrotic tissue and pulp residues that are less vital. The higher the concentration of NaOCl, the higher the level of toxicity.<sup>22</sup> The disadvantage of NaOCl is that it is cytotoxic because it can cause fatal injury if it reaches the periapical area. When NaOCl is in contact with vital tissue, NaOCl rapidly oxidizes the surrounding tissue causing rapid hemolysis and ulceration, inhibition of neutrophil migration, and destruction of endothelial cells and fibroblasts.<sup>23</sup> NaOCl can also cause serious tissue damage if the solution is extruded during the application of the NaOCl material to the periapical tissue. If NaOCl extrudes into the periapical tissue, it can cause flare-ups, swelling, and redness.<sup>22,24</sup> According to the research of Menezes et al in 2004 showed that 2.5% NaOCl was not able to completely eliminate the bacteria *Enterococcus Faecalis*.<sup>25</sup> 17% EDTA is relatively non-toxic and slightly irritating in solution.<sup>26</sup> The disadvantage is that EDTA only dissolves dentin so that it will cause peritubular and intratubular dentin erosion which causes the dentin structure to become irregular and reduces density and adaptation between sealer and dentin. EDTA causes dentin erosion through the demineralization process and excessive opening of dentinal tubules so that it can have a negative impact on the bonding and sealing process.<sup>27,28</sup>

Flare-ups due to dressings root canal may be due to the limited effectiveness of  $\text{Ca}(\text{OH})_2$  in eliminating endodontic pathogenic bacteria such as *Enterococcus Faecalis* and species *Candida* which can cause various incidences of recurrent infections and flare-ups.<sup>4,29</sup> Several studies have shown that  $\text{Ca}(\text{OH})_2$  has limited effectiveness in reducing bacteria than the use of triple antibiotic paste and ledermix which is more effective in reducing the occurrence of flare-ups. Flare-ups can occur due to residual  $\text{Ca}(\text{OH})_2$  deposited at the third end of the root canal, so prior to permanent obturation,  $\text{Ca}(\text{OH})_2$  must be completely removed from the root canal. If this is not done, the result will be a chemical reaction between the  $\text{Ca}(\text{OH})_2$  residue in the root canal and the material sealer which can reduce the flowability and working time of the sealer so that it will lead to a poor prognosis of root canal treatment which can lead to extrusion. periapical and root canal treatment failure that can cause pain (flare-up).<sup>30</sup>

From the data of Table 10, it can be seen that flare-ups can be caused by the root canal obturation technique, namely the obturation technique single cone. One of the key aspects of successful endodontic treatment is to maximally obturate the prepared root canal space. About 60% of root canal treatment failures are caused by incomplete obturation of the root canal Single cone technique is a root canal filling method by inserting a gutta point (cone) into the root canal. In this technique, is used single cone gutta percha which has the same tip diameter and taper as the file last used for shaping.<sup>26</sup> Flare-up due to this obturation technique can be caused because the obturation technique Single Cone does not use compaction forces in filling the root canal material

so that the material sealer does not fill the last apical millimeter of the root canal where this can cause periapical leakage. In conclusion, the 50 patients who underwent root canal treatment with the diagnosis of irreversible pulpitis in RSKGMP Airlangga University, there are 14 people (28%) patients who experience flare-ups.

## REFERENCES

- Riset Kesehatan Dasar (Riskesdas). 2018. Laporan Nasional Riskesdas 2018. Badan Penelitian dan Pengembangan Kesehatan Kementerian RI tahun 2019.
- Dean, J. A., Vinson, L. A. W. *Front Matter*, McDonald and Avery's Dentistry for the Child and Adolescent. 2016;
- Yamauchi, Y., Cooper, P. R., Shimizu, E., Kobayashi, Y., Smith, A. J., Duncan, H. F. 'Histone Acetylation as a Regenerative Target in the Dentine-Pulp Complex', *Frontiers in Genetics*, 11(February). 2020;pp. 1–8.
- Garg N., Garg A. *Textbook of Endodontic*. 4th Ed. Jaypee Brothers Medical Publishers (P) LTD, New Delhi, India; 2019.
- Lin, L. M., Ricucci, D., Saoud, T. M., Sigurdsson, A., Kahler, B. *Vital Pulp Therapy of Mature Permanent Teeth With Irreversible Pulpitis From The Perspective of Pulp Biology*. *Australian Endodontic Journal*. 2020;46(1), pp. 154–166.
- Sadaf, D. 'Success of Coronal Pulpotomy in Permanent Teeth with Irreversible Pulpitis: An Evidence-based Review', *Cureus*. 2020;12(1), pp. 23–27.
- Tabassum, S., Khan, F. R. *Failure of Endodontic Treatment: The Usual Suspects*. *European Journal of Dentistry*. 2016;0(1), pp. 144–147.
- Singh, A., Konark., Kumar, A., Nazeer, J., Singh, R., Singh, S. *Pedodontics and Preventive Dentistry*. 2019;38(), pp. 79–83.
- Anju Singh, Konark, Abhas Kumar, Jazib Nazeer, Rohit Singh, Supriya Singh. 'Pedodontics and Preventive Dentistry', 37(September). 2019;pp.79–83.
- Shahi, S., Asghari, V., Rahimi, S., Lotfi, M., Samiei, M., Yavari, H., Shakouie, S., Nezafati, S. *Postoperative Pain After Endodontic Treatment of Asymptomatic Teeth Using Rotary Instruments: A Randomized Clinical Trial*. *Iranian Endodontic Journal*. 2016;11(1), pp. 38–43.
- Makanjuola, J. O., Umesi, D. C., Oderinu, O. H. *Comparison of The Incidence of Flare-Up and Time Efficiency in Single Visit Root Canal Treatment Employing Either Rotary or Manual Step-back Canal Preparatory Technique*. *Nigerian Postgraduate Medical Journal*. 2018;25(2), pp. 19–26.
- Alamassi, B. Y. *Endodontic Postoperative Pain: Etiology and Related Factors – An Update*. *International Journal of Dental Sciences and Research*. 2017;5(2), pp. 13–21.
- Kumar, A., Tamanna, S., Iftikhar, H. *Intracanal Medicaments – Their use in Modern Endodontics: A Narrative Review*. *Journal of Oral Research and Review*. 2019; 11(2), p. 94.
- Yuanita, Tamara. *Flare-Up Endodontic*. Airlangga University Press. ISBN : 978-602-473-068-0, pp.5; 2020.
- Onay, E. O., Ungor, M., Canan Y. A. *The Evaluation of Endodontic Flare-ups and Their Relationship to Various Risk Factors*. *BMC Oral Health*. 2015;15(1), pp. 1–5.
- Nair, Manuja., Rahul, J., Devadathan, A., Mathew, Josey. *Incidence of Endodontic Flare-ups and Its Related Factors : A Retrospective Study*. *Journal of International Society of Preventive & Community Dentistry*. 2017;7(4).
- Alshehri, A. A., Alshraim, R. A., Abo Dawood, A. A. *Endodontic Flare-Ups : A Study of Incidence and Related Factors*, *The Egyptian Journal of Hospital Medicine*. 2018; 70(2), pp. 349–353.
- Aoun, C., El Costa, N., Naaman, A., Zogheib, C., Khalil, I. *Post-endodontic Flare-ups After a Single-visit Treatment Using The FUI Scoring Method and Associated Factors: A Clinical Prospective Study*. *Journal of Contemporary Dental Practice*. 2019;20(9), pp. 1033–1040.
- Vieyra, J. P., Enriquez, F. J. J., Acosta, F. O., Guardado, J. A. *Reduction of Postendodontic Pain After One-visit Root Canal Treatment Using Three Irrigating Regimens With Different Temperature*. *Nigerian journal of clinical practice*. 2019;22(1), pp. 34–40.
- El Mubarak AH, Abu-bakr NH, Ibrahim YE. *Postoperative pain in multiple-visit and single-visit root canal treatment*. *J Endod*. 2010 Jan;36(1):36-9.
- Kashefinejad, M., Harandi, A., Eram, S., Bijani, A. *Comparison of Single Visit Post Endodontic Pain Using Mtwo Rotary and Hand K-File Instruments: A Randomized Clinical Trial*. *J. Dent*. 2016;686 (Tehran) 13, 10–17.
- Dioguardi, M., Giola, G. D., Illuzzi, G., Laneve, E., Cocco, A., Troiano, G. *Endodontic Irrigants: Different Methods to Improve Efficacy and Related Problems*. *European Journal of Dentistry*. 2018;12(3), pp. 459–466.
- Guivarc'h, M., Ordioni, U., Ahmed, H. M., Cohen, S., Catherine, J. H., & Bukiet, F. *Sodium Hypochlorite Accident: A Systematic Review*. *Journal of endodontics*, 2017;43(1), 16–24.
- Doumani, M., Habib, A., Doumani, A., Kinan, M., Seirawan, Sadeka, M.A., Alfaith, H., AlQaddah, M. *A Review: Sodium Hypochlorite (NaOCl) Accident Between Diagnosis and A Review: Sodium Hypochlorite (NaOCl) Accident Between Diagnosis and Management*. *IOSR Journal of Dental and Medical Sciences*. 2018;16(9), pp. 78–81.
- Prada, I. Micó-Muñoz, P., Giner-Lluesma, T., Micó-Martínez, P., Muwaquet-Rodríguez, S., Albero-Monteagudo, A. 2019. *Update of The Therapeutic Planning of Irrigation and Intracanal Medication in Root Canal Treatment. A literature review*. *Journal of Clinical and Experimental Dentistry*. 2019;11(2), pp. e185–e193.
- Grossman, L.I. *Grossman's Endodontic Practice*. 14th Ed. Wolters Kluwer Health, India; 2021.
- Ariani, T. N., Zubaidah, N., Mudjiono, M. *The Effectiveness of 2.5% NaOCl Irrigation and 17% EDTA Against the Sealing Ability of Resin Paste*. *Conservative Dentistry Journal*. 2020;9(2), p. 105.
- Arslan, S., Balkaya, H., Çakir, N. N. *Efficacy of Different Endodontic Irrigation Protocols on Shear Bond Strength to Coronal Dentin*. *Journal of Conservative Dentistry*. 2019;22(3), pp. 223–227.
- Kumar, A., Tamanna, S., Iftikhar, H. *Intracanal Medicaments – Their use in Modern Endodontics: A Narrative Review*. *Journal of Oral Research and Review*. 2019;11(2), p. 94.
- Adisetyani, Y., Mulyawati, E., Santosa, P. *Perbedaan Kebersihan Sepertiga Apikal Dinding Saluran Akar Dari Residu Kalsium Hidroksida Pasca Pembersihan Dengan Teknik Irigasi Manual, Sonik dan Endovac*. *Jurnal Kedokteran Gigi*. 2016;7(2), pp. 199–205