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Original Article

Effect of Ascorbic Acid as A Final Flush on Post Operative Pain After Single Visit Root Canal Treatment for Patients with Symptomatic Irreversible Pulpits Related to Mandibular Molars: Randomized Controlled Trial

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Abstract

Aim: This research aimed to assess the effect of 20% ascorbic acid final flush on post operative pain intensity in mandibular molars with symptomatic irreversible pulpitis after single visit root canal treatment.

Subjects and methods: Thirty patients were randomly divided into two groups (n = 15), saline (group A) and ascorbic acid (group B). After completion of mechanical preparation using Mpro rotary system in a single visit and using sodium hypochlorite 2.5% as an irrigant, group A received 3ml of saline as a final flush for each canal for 1 minute. Group B received also the same saline flush of group A then 3ml of 20% ascorbic acid as a final flush for each canal. Dryness of the canals and obturation were done with gutta-percha 0.04 by lateral compaction technique. postoperative pain was recorded immediately after obturation and at 6- 12- 24 and 48 hours postoperatively on numerical rating scale chart (NRS) and analgesics consumption up to 48 hours postoperatively. NRS scores were collected and statistically analysed by unpaired student t-test and Mann-Whitney test ($p < 0.05$).

Results: For pain incidence, intensity and analgesics consumption there was no statistically significant difference could be demonstrated regarding the numerical rating scale score between the two groups at any time points ($p < 0.05$).

Conclusion: Within the study limitations, using 20% ascorbic acid as a final flush irrigation did not significantly affect neither the post root canal treatment pain nor the consumption of analgesics in mandibular molars with symptomatic irreversible pulpitis.

Keywords: Final flush; Postoperative pain; Ascorbic acid; Saline, Symptomatic irreversible pulpitis.

Introduction

Pain is one of the main reasons for dental anxiety. Some patients experience discomfort following root canal treatment (RCT). Postoperative pain (PP) is the name given to this condition. According to reports, more than 50% of patients who had any discomfort following an RCT said that their condition was severe and negatively impacted their quality of life.[1]

Acute inflammation of the periapical tissues as a result of chemical, mechanical, and/or microbiological damage of the periapical region during RCT causes postoperative discomfort so it is a multifactorial condition.[2]

Irrigation solution type and concentration are two parameters that influence discomfort following RCT. The concentration of sodium hypochlorite (NaOCl) (the gold standard irrigation solution) affects PP; a greater concentration of the solution results in more PP.[3]

Various approaches were considered to decrease postoperative pain that happens in relation to NaOCl like property of NaOCl depends on its concentration.[4] So, as an attempt to decrease or eliminate the remnants of NaOCl from the canal after cleaning and shaping, ascorbic acid was considered to be used in this study.

A water-soluble, carbohydrate-like compound called ascorbic acid (AA) or vitamin C plays a crucial role in several metabolic processes. It is necessary for the production of collagen, a protein crucial for the development of connective tissue and for the healing of wounds. It aids in boosting the immunological system, beside that it is an antioxidant; preventing reactive molecules called free radicals from destroying cells and tissues.[5]

So, as an antioxidant it can eliminates the reactive oxygen species and therefore decreases the inflammation, tissue destruction, pain and accelerates healing. It also neutralizes the chlorin content and upon the reaction with the chlorin produces sodium chloride (saline), water and sodium ascorbate which is also an antioxidant, so can help in healing process.[6]

There are too many applications of ascorbic acid in dentistry. It has been tested for its efficacy in dentin conditioning and increasing tensile bond strength of composite application and it showed promising results[7], It is injected directly in the gingiva in cases of gingivitis and some of the cases showed resolved inflammation from only one dose[8], AA supplementation accelerates healing process after dental implants and bone graft procedures[9] and it is used as a dentin matrix metalloproteinases inhibitor (bio-modifier) so increase the longevity of resin- dentin bond strength.[10]

Besides that, according to its efficacy in removing chlorin content and its antioxidant, antimicrobial, healing property and in the aim to reduce post endodontic pain and analgesics consumption we hypothised that ascorbic acid can reduce post endodontic pain. So, in this study we decided for the first time to test and compare ascorbic acid 20% effect in reducing post operative pain and analgesics consumption in symptomatic in symptomatic irreversible pulpitis in mandibular molars versus to saline.

Subjects and Methods

This study was conducted in the Endodontics department, Faculty of Dentistry, Cairo University, Cairo, Egypt between September 2022 and January 2023. The protocol for the study was approved by the University's Research Ethics Board. Sample size was calculated using the (PS software) and was found to be 12 patients per group, making the total sample size 24 patients (2 groups), increased to 30 patients to compensate for the 15% dropout. Patients were randomly assigned into two groups by using a Web program available at www.randomizer.org.

The design of this study was two arm parallel double-blinded randomized controlled trial with allocation ratio (1:1). The patients were randomly divided into two groups (n=15). A random sequence was generated by a computer software,

(http://www.random.org/). In the center of Evidence Based Dentistry, Cairo University, the table was kept with the assistant supervisor.

Allocation concealment was done by a phone call, the assistant supervisor was contacted for each patient at the time that the patient presents for study inclusion. The assistant supervisor generated the random sequence and assign the study participants to one of the 2 groups of the trial (intervention and control). patients were not aware of the intervention and the treatment groups were anonymous to the assessing statisticians at the end of the trial.

The inclusion criteria were healthy patients, aged 18-60, having restorable lower molar teeth with sharp pain (not less than 7 on a NRS chart) indicating symptomatic irreversible pulpitis with normal periapical radiograph appearance.

Inclusion and exclusion criteria:

The exclusion criteria were medically compromised, allergic patients, pregnant women and lower molars that were non-restorable, c-shaped canals, necrotic, swelling, immature, mobile. The tooth was excluded radiographically if there was periapical radiolucency or if there was any indication of external or internal root resorption, vertical root fracture, calcification, or perforation.

Treatment procedure:

Informed consents were signed. Preoperative pain levels were measured on NRS charts, and demographic data such as age, gender, and number of teeth was recorded. The diagnosis of symptomatic irreversible pulpitis was made based on a history of intense, throbbing pain that was either spontaneous or induced and persisted for some time after the stimulus was removed. When the patient sleeps down or at night, their pain may get worse.

A single operator performed all the procedures. Patients received 1 cartridge of Lidocaine 2% with Levonordefrin 1:20000 (Alexandria, EGYPT).Rubber dam isolation and access cavity preparation were performed. The diagnosis of symptomatic irreversible pulpitis is further confirmed by bleeding from the canals after the access cavity. The canals were scouted using #8 hand stainless steel K files (Dentsply Maillefer, Ballaigues, Switzerland). Working length was determined using a E-pex apex locator (Changzhou Sifary Medical Technology Co., Ltd) and confirmed radiographically. Rotary MPro (IMD,Shanghai, China) system with endo motor E-connect (Changzhou Sifary Medical Technology Co., Ltd) set to the instructions provided by the manufacturer was used to prepare the canals. The files were used sequentially. The coronal two-thirds of the canal was enlarged using MPro file (18/.09) as an orifice opener in a continuous motion (speed 500 rpm, torque 3Ncm) followed by, file (20/.04), (25/.06), then 35/.04). In and out motions were used in the cervical, middle, and apical thirds. Between each successive files 2.5 % sodium hypochlorite (NaOCl) irrigation was used in a 30-gauge side vented needle.

The control group (group A): After mechanical preparation, 3 ml of 0.9% saline in each canal was used for 1 minute as a final flush. Obturation was done for all participants. Gutta-percha master cones (Gutta- percha points, Meta Biomed Co., Ltd. Chungbuuk, Korea) corresponding to the final file were used and master cone radiographs were taken. Paper points were used to dry the canals (Gutta-percha points, Meta Biomed Co., Ltd. Chungbuuk, Korea) corresponding to the sizes of the master cone and obturated by lateral compaction technique. A resin-based root canal sealer (ADseal, Meta Biomed CO., LTD, Korea) was used. A temporary restoration (Cavit, 3M ESPE AG, Germany) was placed and a final radiograph was taken.

The intervention group (group B): After irrigation of each canal with 3ml saline, each canal was received 3ml final flush of 20% ascorbic acid (Memphis, Egypt) (Figure1) for 1 minute.

Ibuprofen 400 mg was prescribed in case of severe pain. The pain immediately after obturation was recorded and patients were instructed to record pain at 6, 12, 24, 48 hours postoperatively on a NRS chart and record if they needed to take analgesics tables within 48 hours post operatively.

NRS scale is a pain scale from 0 to 10 assessing pain intensity in which 0 refers to no pain and 10 reflecting the most severe pain. In the specific time points mentioned, the patients were instructed to simply give a number corresponding to the pain intensity felt.

Patients returned to the clinic after the 2-days interval to give the operator the pain charts and for receiving the final restoration.

Statistical analysis:

Statistical analysis was done by SPSS version 28 (IBM Co., Armonk, NY, USA). Quantitative parametric data were presented as mean, standard deviation (SD) and range and were analysed by unpaired student t-test. Quantitative non-parametric data were presented as the median and interquartile range (IQR) and were analysed by Mann-Whitney test.

Categorical variables were presented as frequency and percentage (%) and analysed using the Chi-square test or Fisher's exact test. Friedman's test was used to compare ordinal variables at different timepoints.

To determine the level of correlation between two quantitative variables, the Spearman's rank correlation coefficient was performed. Statistical significance was defined as a P-value of 0.05 or below.

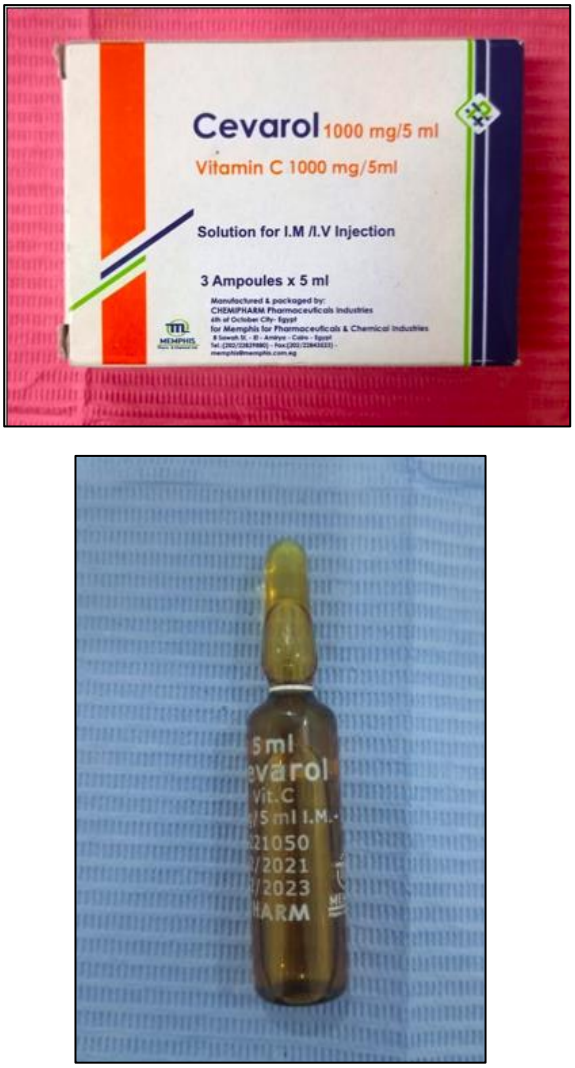

Figure 1: Ascorbic acid ampoule (20% conc, Cevarol, Memphis, Egypt)

Results

The Consort diagram is representing the summary of the study. (Figure 2). Thirty patients were divided at random into two groups of 15.

As shown in table 1, the two studied groups were comparable in terms of age (with means of 32.73 ± 11.2 and 28.6 ± 8.36 years) and sex distribution (33.3% males, 66.7% females vs 20% males, 80% females). Demographic data did not show any statistically significant differences between thegroups (P >.05).

In experimental group which received

ascorbic acid as a final flush, the pain was significantly different between different timepoints (P<0.001) as it was relieved immediately after obturation, 6, 12, 24 and 48 hours as compared to preoperative pain (P<0.05). Upon comparison between the postoperative pain intensity, it was significantly higher after 6 and 12 hours than the pain immediately after obturation (P=0.002, 0.036 respectively) while was significantly improved after 48 hours compared to 6 hours evaluation (P=0.022). (Table 2)

Likewise, in control group who received saline, the pain was significantly relieved immediately after obturation, 6, 12, 24 and 48 hours as compared to preoperative pain (P<0.05). Upon comparison between the postoperative pain intensity, it was significantly higher after 6 hours than the pain immediately after obturation (P=0.04) while was significantly improved after 24 hours. However, no statistically significant difference could be demonstrated regarding the numerical rating scale score between the intervention and control groups at any time points. (Table 2) (Figure 3).

Regarding the analgesic's consumption, there was no statistically significant difference between the two groups in terms of analgesic use 2 days postoperatively, as 26.7% of the experimental group required analgesics the 1st day with twice the risk as the control group while the 2nd day, 13.3% of both groups required analgesics. (Table 3)

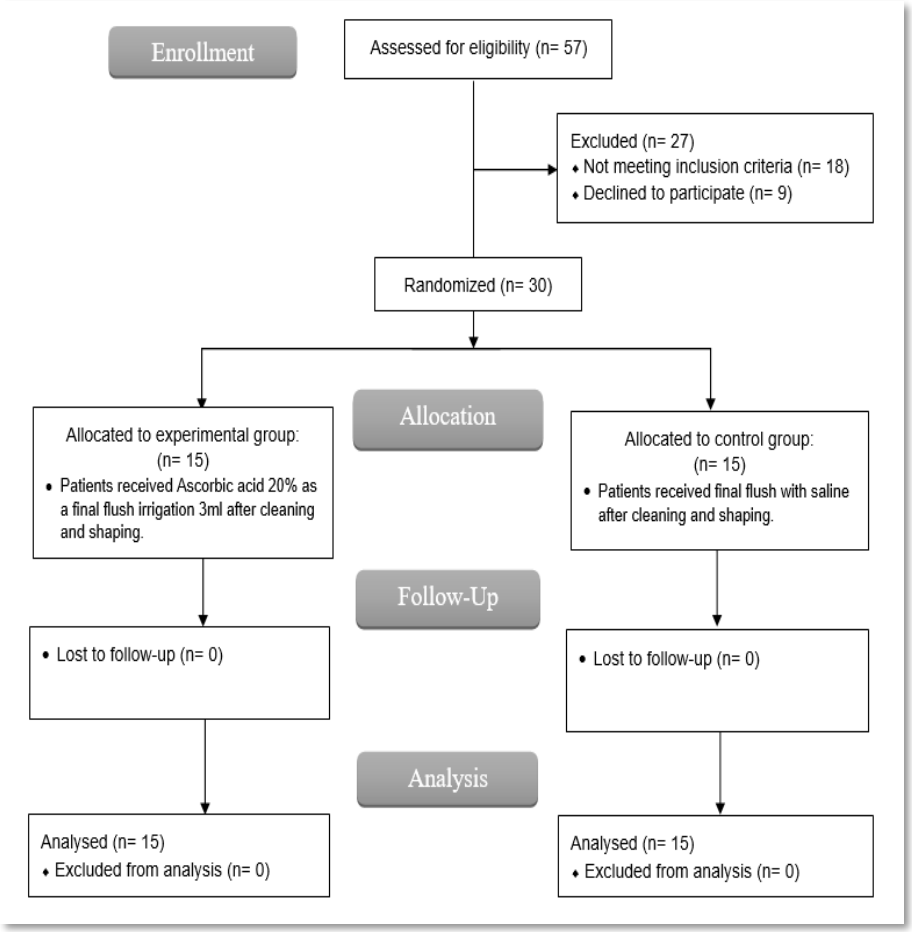

Figure 2: Consort flow chart

Table (1): Descriptive statistics, 95% confidence interval and the results of Mann – Whitney U test for comparison of age between the wo groups.

		Experimental group (n=15)	Control group (n=15)	P value
Age (years)	**Mean ± SD**	32.73 ± 11.2	28.6 ± 8.36	0.262
	Range	21 – 59	18 - 45	
Sex	**Male**	5 (33.3%)	3 (20%)	0.682
	Female	10 (66.7%)	12 (80%)	

Table 2. Descriptive statistics. 95% interval and the result of Mann-Whitney U test for comparison of pre and postoperative pain intensity between the two groups. (median and interquartile range)

		Experimental group (n=15)	**Control group (n=15)**	**P between groups**
Preoperative	median (IQR)	8 (6 – 9)	7 (5 – 8)	0.399
	range	5 – 10	4 - 10	
Immediately postoperative	median (IQR)	0 (0 – 0)	0 (0 – 0)	0.15
	range	0 – 0	0 - 3	
6 h	median (IQR)	3 (0 – 6)	2 (0 – 6)	0.78
	range	0 – 9	0 - 10	
12 h	median (IQR)	1 (0 – 4)	0 (0 – 3)	0.28
	range	0 – 7	0 - 8	
24 h	median (IQR)	0 (0 – 4)	0 (0 – 0)	0.069
	range	0 – 7	0 - 5	
48 h	median (IQR)	0 (0 – 1)	0 (0 – 0)	0.085
	range	0 – 6	0 - 3	
P between measurements		**<0.001**	**<0.001**	

	Experimental group (n=15)	**Control group (n=15)**	**RR (95%CI)**	**P value**
1st day	4 (26.7%)	2 (13.3%)	2(0.429 to 9.321)	0.651
2nd day	2 (13.3%)	2 (13.3%)	---	>0.999

Table 3. Analgesic tablets use after endodontic treatment of both groups

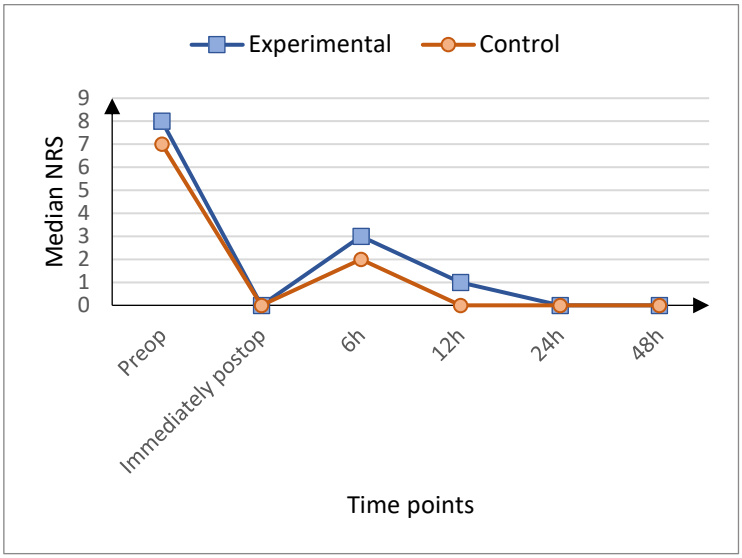

Figure 3: Line chart representing the change in the pain intensity with time in the 2 groups

Discussion

This parallel-design randomized clinical trial's objective was to compare the postoperative pain intensity after RCT and after making a final flush irrigation with 20% ascorbic acid or 0.9% saline solution under controlled clinical conditions.

Post endodontic pain usually occurs during the first 2 days after treatment, but occasionally it continues for several days.[11]

Despite the ongoing controversy in the literature regarding the pulpal status (vital or necrotic) and the prevalence and severity of post operative pain, multiple studies reported a strong correlation between pulp vitality and the presence of preoperative symptoms and the occurrence of postoperative pain.[12] This is explained by the fact that the injury caused by root canal treatment to the periapical vital tissue in teeth with vital pulp increases the rates at which inflammatory and pain mediators such prostaglandins, leukotrienes, serotonin, histamine, and bradykinin are produced.[13]

In addition, that prevalence of post endodontic pain having a strong correlation with tooth type, as the pain prevalence increases in mandibular molar teeth due to the anatomical complexities.[14,15]

Assessing pain intensity of the patient can be done by multiple unidimensional scales, one of them is the numerical rating scale (NRS). It can be administered verbally (therefore also by telephone) or graphically for self-completion.

The respondent is asked to indicate the numeric value on the segmented scale that best describes their pain intensity. Along with the ease of scoring and preference of the patient to give a pain number, evidence stated that it has a high test–retest reliability.[16]

All confounding factors that could affect our study were eliminated as much as possible by standardizing the root canal treatment steps done in both groups. The only variable was ascorbic acid

There are too many strategies to decrease post operative pain for example intracanal cryotherapy with saline, intraoral cryotherapy with cold ice pack and using analgesics as

nonsteroidal anti-inflammatory drugs. None of them eliminates completely the post operative pain except for the analgesics if they are prescribed around the clock so it is considered the golden standard. But it has too many side effects on the renal, cardiac, hepatic and gastric side effects.[17,18]

Ascorbic acid is a water-soluble vitamin. The human body totally relies on external supplementation as it cannot produce it. Any drop in AA's level results in lower immunity levels and more infections since AA has a clear function in maintaining a robust immune system.[19] The quality and activity of many immune cells, including neutrophils, natural killer cells, macrophages, and lymphocytes are improved by AA. It increases the synthesis of antibodies and lymphocyte proliferation.[5]

Also, AA is well-known for having a variety of anti-inflammatory effects. Since C-reactive protein (CRP) is a stable downstream marker of inflammation in plasma, it is assumed that AA usage results in a lower level of it.[20] AA boosts the synthesis of collagen types I and X, which are essential for matrix formation and the stimulation of osteoblast development and differentiation. In order to ensure adequate bone density, it is also necessary in osteoblasts stimulation and increased expression of osteocalcin and osteonectin (extracellular matrix protein that plays a vital role in bone mineralization.[21]

AA can inhibit other regulatory mechanisms underlying bacterial biofilm development, this decreases the level of extracellular poly saccharides (EPS) biosynthesis, causing depletion of the polysaccharide part of the matrix. When EPS levels drop above the critical point, bacterial cells are totally exposed to the medium. At this stage, cells can be killed by ascorbic acid -induced oxidative stress, or by other antibiotics or treatments.[22]

Additionally, AA had significant antibacterial efficacy against streptococcus mutans, staphylococcus aureus, prophyromonas gingivalis, candida albicans, and enterococcus faecalis. The predicted minimal inhibitory concentration for ascorbic acid against oral bacteria and fungi were 10mg/ml. ascorbate was able to suppress the oral biofilm at 20 mg/ml.[23]

It has also antioxidant property so can help in decreasing the inflammation. It also has its unique property of neutralizing chlorin content into water, saline and dehydroascorbic acid which also has anti-inflammatory property.[6] That's why this is the first clinical trial to consider using AA as a final flush and inspect its effect on post operative pain.

The protocol for the control group irrigation was a 1-minute flush irrigation using 3 mL of 0.9 % salinewith 30-gauge needle shorter than the working length with 1 mm. The side vented needles have the advantage of not making high apical pressure that can increase the risk for apical extrusion of debris if it exceeded the central venous pressure, which in turn increases the probability of postoperative pain so more safety than open ended needles.[24]

The intervention group was 20% ascorbic acid, as this percentage is the most efficient and if this concentration increased, it will result in allergy. The final flush was done after irrigating each canal with 3 ml of 0.9% saline.

After final flushes application in the intervention and control group, the teeth were obturated, temporary filling was applied and patients were instructed to fill the NRS scale chart.

The limitations of this study were pain threshold differences between each patient as that will affect the post operative pain and analgesics consumption, the body response to the treatment,

manufactural defects of the files as that will affect the cutting efficiency of the files and debris extrusion, the variability of patients opinions in assessing their pain intensity levels even pre or post operative pain, the length of the single visit session as longer procedure leads to high probability of post operative pain, sealer extrusion during obturation, NRS as it is a unidimensional method to measure the pain and

the last limitation is the small number of the sample size.

Within previous limitations of the present study, 20% ascorbic acid and 0.9 %saline final

flushes did not significantly reduce neither post operative pain intensity nor analgesics consumption after RCT up to 48 hours in mandibular molars with symptomatic irreversible pulpitis.

Ascorbic acid will not reduce the known levels of post operative pain, it is totally un comparable with other methods of controlling post operative pain like cryotherapy and nonsteroidal anti-inflammatory drugs that can reach to pain intensity level of 0 on NRS or just mild pain from 1-3[25,26] and it is not expected to control post operative pain in any other conditions like necrotic cases or abscesses. But on the other hand, at least AA did not get the pain worse, So, it is a result in itself as it makes

it possible to make good use of ascorbic acid properties. It can be tested as a reducing agent in removing smear layer after mechanical preparation, an agent increasing synergistic effect of antibiotics and affecting the biofilms, a material increasing the quality of pulp regeneration, a material neutralizing chlorin content in cases of sodium hypochlorite accidents in case reports and an intrafilamentary injection in cases of apical periodontitis to decrease the inflammation, pain and accelerates healing.

Besides its good properties, AA has very good safety profile since the toxic levels that cause cellular death are 100-200 times higher than the daily therapeutic dose and the only and its topical use leads to some urticaria and erythema multiform but this is mild and rare cases.

Conclusion:

Using ascorbic acid 20% as a final flush irrigation did not significantly reduce neither the post root canal treatment pain nor the consumption of analgesics in mandibular molars with symptomatic irreversible pulpitis.

Conflict of Interest:

The authors declare no conflict of interest.

Funding:

This research received no specific grant from any funding agency in the public, commercial, or not-for-profit sectors

Ethics:

This study protocol was approved by the ethical committee of the faculty of dentistry- Cairo university on: 27/9/2022, approval number: 8/9/2022.

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