Effect of Different Host-Related Factors on Postoperative Endodontic Pain in Necrotic Teeth Dressed with Interappointment Intracanal Medicaments: A Multicomparison Study

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Abstract

Objectives The current study aimed to assess the impact of factors such as age, gender, and the tooth type on postoperative endodontic pain in necrotic teeth with symptomatic periapical periodontitis and radiolucency dressed randomly with either calcium hydroxide or propolis paste.

Materials and Methods The standard chemomechanical root canal preparation of 80 teeth was performed by the primary investigator. The intracanal medicaments were inserted by the secondary operator. Patients self-recorded their postoperative endodontic pain intensity with the help of visual analog scale at 4, 12, 24 (day 2), 48 (day 3), and 72 (day 4) hours. During analysis, patients (68/80) were grouped according to gender, age, and the tooth type.

Statistical Analysis Mann–Whitney's *U* test was applied for mean pain score comparison between genders and between tooth type. Kruskal–Wallis' test was applied for mean pain score comparison between the age groups.

Results No significant difference ($p > 0.05$) in pain scores was found between the age groups and between the tooth types. Males had significantly higher pain scores as compared with females at days 2 ($p = 0.035$), 3 ($p = 0.023$), and 4 ($p = 0.020$).

Conclusion The results suggested that there was no impact of age and tooth types on postoperative endodontic pain.

Keywords
- age
- gender
- pain
- root canal
- tooth type

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Introduction

The most persuasive factor for a patient to visit a dental health care professional is the existence of odontalgia. Accordingly, the pain after a dental therapy results in demotivation of the patient. Unfortunately, mild to severe pain following a tooth-preserving therapy such as root canal treatment is reported to be experienced by 40% of the patients.[1] The severe postoperative endodontic pain is extremely distressing for both the patient and the dentist. Such acute exacerbation of pain with or without swelling is called "flare-up." Owing to the contrasting definitions and criteria used for the identification of flare-up, a wide variation in its incidence has been observed in the literature. Generally, the flare-up incidence is shown to vary from 1.5 to 12.3%.[2-5]

Postendodontic pain is a complex, multifactorial phenomenon. The factors involved can be categorized as: (1) predisposing or host-related factors, such as patient's age, gender, tooth type, host's immunity, psychological factors, and local tissue changes[2,4]; (2) the iatrogenic factors, such as overinstrumentation and chemical or obturating material extrusion[6]; and (3) the microbial factors.[7] The iatrogenic errors can be avoided by a careful root canal preparation technique. However, in most cases, the postoperative endodontic pain occurs when the infected debris of the necrosed tooth gets extruded into the periapical area.[7] Few studies have shown a positive correlation between the severity of postoperative endodontic pain and higher age, and the female gender,[2,6] whereas other studies have found no correlation between these variables.[4] Therefore, the impact of host-related factors on postoperative endodontic pain is disputed.

Several strategies are suggested to manage or prevent postinstrumentation pain. These include the implementation of crown-down root canal preparation technique along with copious irrigation[8]; meticulous sterile methods used during all intracanal procedures[7]; usage of anti-inflammatory systemic medications[9]; and insertion of intracanal medicaments.[3,10,11] The interappointment intracanal medicaments are suggested for disinfection of the infected root canal system in multivisit endodontic treatment. Calcium hydroxide ($Ca(OH)_2$) is considered as a universal intracanal medicament for this purpose.[11,12] Additionally, it is hypothesized to exert pain-preventing effect indirectly through its antimicrobial and tissue modifying properties.[13]

The naturally available materials have become a center of attention to the scientific community recently. These materials are perceived as having eminent antimicrobial effectiveness and biocompatibility.[14,15] One of these materials is propolis. It is a resinous natural byproduct, obtained from various components of the plants by the honey bees (*Apis mellifera* L.). The honey bees melds it with the salivary enzymes and deposits it into the beehive.[15,16] Propolis has shown to exert strong antimicrobial and anti-inflammatory effects.[17-19] *In vivo* experiments have found propolis to be a better antimicrobial and biocompatible product as compared with $Ca(OH)_2$ when used as an intracanal irrigant and a direct pulp capping material.[20,21] Moreover, it was found to have equal effectivensss as $Ca(OH)_2$ for postendodontic pain prevention when utilized as an intracanal medicament.[22] The mechanism of anti-inflammatory action of propolis can be ascribed to inhibition of lipopolysaccharide-induced secretion of inflammatory cytokines and chemokines.[23]

The present study utilized the data[24] of the previously published clinical trial, which showed equal effectiveness of $Ca(OH)_2$ and propolis paste in preventing the postoperative pain.[22] The aim of the current study was to evaluate the effect of variables such as age, gender, and tooth type on postoperative endodontic pain in necrotic teeth with symptomatic periapical periodontitis and visible periapical radiolucency dressed with either $Ca(OH)_2$ or propolis.

Materials and Methods

The current study was a simple comparative study. The protocol was approved by Institutional Review Board, Dow University of Health Sciences (DUHS; ref no: IRB-847/DUHS/Approval/2017/52). The study protocol was published at www.ClinicalTrials.gov (study identifier: NCT03723980) and www.isrctn.com (study ID: ISRCTN66816132). The study was conducted in Department of Operative dentistry/Endodontics, DUHS. Only those patients were included in the experiment, who agreed to participate and signed the consent form. The sample size of our previous study,[22] from which the raw data were utilized was calculated (with 90% power of the test and 95% confidence interval) with the help of PASS v11 software (Microsoft, Redmond, Washington, United States) as 52. The sample size was increased to 80 to compensate for expected drop-out. Nonprobability purposive sampling was used to include the patients into the study with the help of following criteria: patients aged 20 to 40 years having single-rooted teeth with pulpal necrosis and symptomatic apical periodontitis with visible radiographic disturbance of periapical lamina dura. The exclusion criteria were based on the following: patients who had taken oral medications preoperatively which could have influenced pain perception; pain related to other teeth; teeth with open apex; teeth with extremely curved or sclerosed canals, dilacerated roots, external and internal root resorption; teeth with occlusal interferences; patients with American Society of Anesthesiologists III or above conditions; patients who could not understand the English or Urdu language; and patients with allergy to bee pollen or honey products. Patient allocation to the intracanal medicament groups in the original study was done using randomized sequence generated online (www.random.org).[22]

Cold spray and electric pulp tests were used to assess the pulp sensibility.[25] The pulpal status of the affected teeth was diagnosed to be necrotic when no response was observed after tooth sensibility tests were performed. Periapical diagnosis was made on the basis of "*endodontic terms glossary*."[26] The healthy teeth, contralaterally, were utilized as a control for these tests. The eligible teeth were anesthetized using either local infiltration technique or inferior alveolar nerve block, depending on the type of teeth being treated. The

standard root canal preparation procedure was implemented using Rotary NiTi file system.[22] The principal investigator was responsible for all of the above-mentioned procedures.

The patients were randomly allocated with the help of the randomized sequence to either $Ca(OH)_2$ group (control group; group I) or propolis group (experimental group; group II).[22] The secondary operator inserted the intracanal medicaments (with the help of lentulospirals) and temporary restoration. Before dismissal, the patients were given the visual analog scale (VAS) to self-record their postoperative endodontic pain intensity at 4, 12, 24 hours (day 2), 48 hours (day 3), and 72 hours (day 4) (time frame = 4 days). VAS consisted of serial number of the patients, pain scores ranging from 0 (no pain) to 100 (worst pain) on a 100-mm line, the time intervals, and the instructions to fill the VAS. The VAS scores were further divided into four parts depending on the type of oral analgesics consumed.[3,22] The patients were asked to rate their postoperative pain intensity scores with the help of the following criteria: (1) from 0 to 24, when no or only mild pain was experienced, and no analgesic was consumed; (2) from 25 to 49, when moderate pain was experienced, and over-the-counter (OTC) analgesics such as paracetamol or ibuprofen were consumed for pain relief; (3) from 50 to 74, when severe pain was experienced, OTC analgesics were ineffective and codeine containing analgesic was consumed for pain relief; and (4) from 75 to 100, when extreme pain was experienced and no medication was effective in reducing the pain. The patients were called back after 4 days. Upon their return, the VAS scores were collected by the principal investigator and forwarded to an independent person for the data analysis. The data analysis was done with the help of Statistical Package for the Social Sciences (SPSS) version 24.0 (IBM Corp., Armonk, New York, United States). For meaningful analysis, the teeth included were distributed into two groups: maxillary single-rooted teeth (MaxSRT) group and mandibular single-rooted teeth (ManSRT) group. For the ease of analysis, age of the patients was divided into four groups: 20 to 24; 25 to 29; 30 to 34; and 35 to 40 years. For comparison of mean pain scores between the genders and between the tooth groups, Mann–Whitney's *U* test was employed. For mean pain scores comparison between different age groups, Kruskal–Wallis' test was used. Significance level was considered as <0.05. Additionally, the descriptive statistics were used to report percentages and numbers.

Results

Both the intracanal medicament groups were homogenous in terms of distribution of baseline characteristics.[3,22] Twelve patients did not return after 4 days (drop-out rate = 15%) and no communication could be established with them. Hence, the outcome of our study was based on 68 patients. The analysis of mean pain score comparison between males (n = 25) and females (n = 43) showed no significant difference at 4 hours (p = 0.41) and 12 hours (p = 0.94) (►**Table 1**). However, on days 2 (p = 0.035), 3 (0.023), and 4 (0.020), males were observed to have significantly higher postoperative pain scores as compared to females. Altogether, ≥ 76% of males and ≥ 83.7% of females were found to have postoperative pain score intensity in a range from 0 to 24 (no or mild postoperative pain score category) at all time intervals. Furthermore, ≤ 24% of the males and ≤ 11.6% of the females were found to have postoperative pain score intensity in a range from 25 to 49 (moderate pain score category) at all time intervals. Only three (6.9%) females at 4 hours and two (4.6%) females at 12 hours had pain score intensity in a range from 50 to 74 (severe pain category).

The analysis of mean pain score comparison between the age groups revealed insignificant difference at all time points (p > 0.05) (►**Table 2**). Only one patient belonging to age group

Table 1 Mean pain score (at 100 mm VAS) comparison between males and females

Time interval	Males (mean ± SD) (n = 25)	Females (mean ± SD) (n = 43)	p-Value
4 h	9.8 ± 11.9	10.4 ± 16.9	0.6 (0.41)
12 h	11.6 ± 14.5	8.8 ± 15.2	2.8 (0.94)
Day 2	7.8 ± 11	2.3 ± 5.8	5.5 (0.035[a])
Day 3	5.8 ± 8.9	1.40 ± 4	4.4 (0.023[a])
Day 4	5 ± 2.9	0.70 ± 2.1	4.3 (0.020[a])

Abbreviations: SD, standard deviation; VAS, visual analog scale.
[a]Significant at 0.05.

Table 2 Mean pain score (at 100 mm VAS) difference between different age groups

Time interval	20–24 (mean ± SD) (n = 6)	25–29 (mean ± SD) (n = 10)	30–34 (mean ± SD) (n = 17)	35–40 (mean ± SD) (n = 35)	p-Value
4 h	7.1 ± 9.1	14.5 ± 15.1	14.6 ± 21.2	7.4 ± 12.1	0.15
12 h	8.3 ± 14.3	12.9 ± 17.9	13.6 ± 16.3	7.4 ± 13.5	0.36
Day 2	0	10.6 ± 13.1	3.7 ± 6.9	3.6 ± 7.7	0.13
Day 3	1.5 ± 3.6	4 ± 9.6	1.5 ± 4.2	3.7 ± 6.9	0.55
Day 4	0	2.1 ± 6.2	0.3 ± 1.2	3.7 ± 7.6	0.17

Abbtreviations: SD, standard deviation; VAS, visual analog scale.

Table 3 Mean pain score (at 100 mm VAS) difference between maxillary and mandibular teeth

Time interval	Maxillary teeth (mean ± SD) (n = 43)	Mandibular teeth (mean ± SD) (n = 25)	p-Value
4 h	7.6 ± 11.3	14.7 ± 19.8	0.078
12 h	9 ± 14.3	11.4 ± 16.2	0.50
Day 2	4.4 ± 8.6	4.2 ± 8.5	0.8
Day 3	3.6 ± 7.4	2 ± 4.8	0.6
Day 4	2.6 ± 7.1	1.8 ± 3.9	0.4

Abbreviations: SD, standard deviation; VAS, visual analog scale.

20 to 24 years (n = 6) had moderate postoperative pain intensity (pain score range = 25–49) at 12 hours. All other patients aged 20 to 24 years were found to have no or only mild postoperative pain intensity (pain score range = 0–24) at all time intervals. In age group 25 to 29 years (n = 10), ≥ 70% of the patients had postoperative pain score intensity from 0 to 24, whereas ≤ 30% of the patients were found to have postoperative pain intensity from 25 to 49. Interestingly, no patients in this age group experienced severe or worst postoperative pain (pain score > 49). In the age group 30 to 34 years (n = 17), ≥ 76% of the patients were observed to have postoperative pain scores in no or only mild postoperative endodontic pain category at all time intervals. Although at 4 hours, 12 hours, and day 2, 11.6, 17.6, and 5.8% of the patients in this group were found to have postoperative pain scores in moderate pain category. Moreover, 11.6 and 5.8% of the patients in this age group had severe pain at 4 and 12 hours. In the age group 35 to 40 years (n = 35), ≥ 85.7% of the patients had postoperative pain scores in no or only mild postoperative pain category at all time intervals, whereas ≤ 11% of the patients in this age group experienced moderate postoperative pain and only one patient at 4 and 12 hours experienced severe pain.

The analyzed MaxSRT (n = 43/68; 63.2%) consisted of maxillary central incisors (4; 9.3%), lateral incisors (7; 16.2%), canines (14; 32.5%), and second premolar (18; 41.8%). The analyzed ManSRT (n = 25/68; 36.7%) consisted of mandibular lateral incisors (3; 12%), canines (2; 8%), first premolars (6; 24%), and second premolars (14; 56%). The analysis showed insignificant difference in postoperative mean pain scores between mandibular and maxillary teeth groups (p > 0.05) at all time intervals (►**Table 3**). Altogether, > 81% of all MaxSRT and ≥ 76% of all ManSRT were found to have postoperative pain scores ranging from 0 to 24 at all time intervals. At 4 hours, 9.3% of all MaxSRT and 12% of all ManSRT were observed to have postoperative pain scores in moderate pain category. At 12 hours, 18.6% of all MaxSRT and 12% of all ManSRT had moderate postoperative pain. On day 2, 9.3% and on days 3 and 4, 4.7% of all MaxSRT had moderate postoperative pain. Similarly, on day 2, 8% of all ManSRT had moderate postoperative pain and none on days 3 and 4. Interestingly, 12 and 8% of all ManSRT had severe postoperative pain at 4 hours and 12 hours as compared to none of MaxSRT at any time interval. The severe postoperative endodontic pain was related to mandibular second premolars (14.3% of all mandibular second premolars) at 4 and 12 hours and one mandibular canine at 4 hours.

Discussion

There is a high disparity in the reported incidence of postoperative endodontic pain in the literature. This variation can be attributed to various factors such as the difference in methods of pain assessment,[2-4,27] difference in the inclusion criteria,[28] quality and methodology of treatment provided,[29,30] the presence or absence of the microbiological[7] or iatrogenic[6] factors, and the difference in host-related factors.[2,4] In our previous study, insignificant difference in postoperative endodontic pain was found between the patients in propolis and $Ca(OH)_2$ medicament groups.[25] We conducted the current study to know the effect of different variables such as age, gender, and tooth type on occurrence and intensity of postoperative endodontic pain using the raw data[24] of our previous study.

The rationale for selection of specific inclusion criteria is described in our previous study.[22] Specific age range (20–40) was selected to limit the difference of pain perception according to age.[31] In the current study, initially at 4 and 12 hours, no difference in postoperative endodontic pain was observed between males and females. However, at days 2 to 4, males experienced significantly higher pain as compared to females. This finding contradicted the literature.[6,32] There was a constant and slow reduction in postoperative pain in males as opposed to females, who experienced dramatic decrease in postoperative pain at day 2. Consequently, a significant difference in mean pain scores between males and females were observed from day 2. The reason for the rapid decline in pain scores in female group is not clear. Interestingly, none of the male patients experienced severe pain (pain score = 50–74) as opposed to three females at 4 hours and two females at day 2. Although these numbers were low, this can be attributed to the variation in physiological reaction to pain or by decreased reporting of pain intensity by males due to their stature in the society as a sign of pain endurance.[33]

The results of current study suggested that there was no difference in postoperative endodontic pain intensity between the different age groups. This finding was in accordance with the previous studies which proposed that age had no influence on postoperative endodontic pain.[34,35] Only five patients between the age 30 and 40 years experienced severe postoperative pain within 12 hours. However, their numbers were low and not meaningful. Similarly, the analysis showed no difference in pain scores between MaxSRT and ManSRT groups. These results were found to concord

with the previous study which suggested that the postoperative endodontic pain was unrelated to the type of tooth.[2] Further analysis revealed that none of the MaxSRT suffered from severe postoperative pain. Comparatively, few mandibular canines and mandibular second premolars suffered from severe postoperative pain. Although their numbers were low, it could be attributed to the complexity of root canal system in ManSRT.[36,37]

One limitation of this study was the unequal and insufficient number of cases in the tested groups, which might have impacted the outcome of the study. The reason for unequal distribution of patients between the groups in this study was that only the raw data of our previously published study was utilized and no further amendment was incorporated. The method of distribution of patients in our previous study was primarily based on two medicament groups regardless of age, gender, and tooth type.[22] Therefore, this study can be considered as a pilot study. Future studies are encouraged to be carried out with equal distribution of the patients into the gender, age, and tooth type groups along with subgroups based on the type of the intracanal medicaments.

Conclusion

Within the limitations of the study, it can be concluded that the majority of the patients irrespective of the age, gender, and tooth type experienced no or only mild postoperative endodontic pain. Moreover, insignificant difference in postoperative pain scores was observed between the age groups and between the tooth groups. Interestingly, males had higher pain scores as compared to females at days 2 to 4. These results suggest that the age (20–40 years) and the tooth type (maxillary or mandibular) had no influence on the incidence of postoperative endodontic pain in necrotic teeth dressed with the intracanal medicaments.

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Conflict of Interest
None declared.

References

1 Pak JG, White SN. Pain prevalence and severity before, during, and after root canal treatment: a systematic review. J Endod 2011;37(4):429–438
2 Azim AA, Azim KA, Abbott PV. Prevalence of inter-appointment endodontic flare-ups and host-related factors. Clin Oral Investig 2017;21(3):889–894
3 Ehrmann EH, Messer HH, Clark RM. Flare-ups in endodontics and their relationship to various medicaments. Aust Endod J 2007;33(3):119–130
4 Imura N, Zuolo ML. Factors associated with endodontic flare-ups: a prospective study. Int Endod J 1995;28(5):261–265
5 Tsesis I, Faivishevsky V, Fuss Z, Zukerman O. Flare-ups after endodontic treatment: a meta-analysis of literature. J Endod 2008; 34(10):1177–1181
6 Torabinejad M, Kettering JD, McGraw JC, Cummings RR, Dwyer TG, Tobias TS. Factors associated with endodontic interappointment emergencies of teeth with necrotic pulps. J Endod 1988;14(5):261–266
7 Siqueira JF Jr. Microbial causes of endodontic flare-ups. Int Endod J 2003;36(7):453–463
8 Aksel H, Küçükkaya Eren S, Çakar A, Serper A, Özkuyumcu C, Azim AA. Effect of instrumentation techniques and preparation taper on apical extrusion of bacteria. J Endod 2017;43(6): 1008–1010
9 Elzaki WM, Abubakr NH, Ziada HM, Ibrahim YE. Double-blind randomized placebo-controlled clinical trial of efficiency of nonsteroidal anti-inflammatory drugs in the control of post-endodontic pain. J Endod 2016;42(6):835–842
10 Ehrmann EH, Messer HH, Adams GG. The relationship of intracanal medicaments to postoperative pain in endodontics. Int Endod J 2003;36(12):868–875
11 Gama TGV, de Oliveira JCM, Abad EC, Rôças IN, Siqueira JF Jr. Postoperative pain following the use of two different intracanal medications. Clin Oral Investig 2008;12(4):325–330
12 Madarati AA, Zafar MS, Sammani AMN, Mandorah AO, Bani-Younes HA. Preference and usage of intracanal medications during endodontic treatment. Saudi Med J 2017; 38(7):755–763
13 Walton RE, Holton IF Jr, Michelich R. Calcium hydroxide as an intracanal medication: Effect on posttreatment pain. J Endod 2003;29(10):627–629
14 Almadi EM, Almohaimede AA. Natural products in endodontics. Saudi Med J 2018;39(2):124–130
15 de Groot AC. Propolis: A review of properties, applications, chemical composition, contact allergy, and other adverse effects. Dermatitis 2013;24(6):263–282
16 Khurshid Z, Naseem M, Zafar MS, Najeeb S, Zohaib S. Propolis: A natural biomaterial for dental and oral healthcare. J Dent Res Dent Clin Dent Prospect 2017;11(4):265–274
17 Suleman T, van Vuuren S, Sandasi M, Viljoen AM. Antimicrobial activity and chemometric modelling of South African propolis. J Appl Microbiol 2015;119(4):981–990
18 Victorino FR, Bramante CM, Watanabe E, Ito IY, Franco SL, Hidalgo MM. Antibacterial activity of propolis-based toothpastes for endodontic treatment. Braz J Pharm Sci 2009;45(4): 795–800
19 Zeitoun R, Najjar F, Wehbi B, et al. Chemical composition, antioxidant and anti-inflammatory activity evaluation of the Lebanese propolis extract. Curr Pharm Biotechnol 2019;20(1): 84–96
20 Jolly M, Singh N, Rathore M, Tandon S, Banerjee M. Propolis and commonly used intracanal irrigants: comparative evaluation of antimicrobial potential. J Clin Pediatr Dent 2013; 37(3):243–249
21 Parolia A, Kundabala M, Rao NN, et al. A comparative histological analysis of human pulp following direct pulp capping with propolis, mineral trioxide aggregate and Dycal. Aust Dent J 2010;55(1):59–64
22 Shabbir J, Qazi F, Farooqui W, Ahmed S, Zehra T, Khurshid Z. Effect of Chinese propolis as an intracanal medicament on post-operative endodontic pain: A double-blind randomized controlled trial. Int J Environ Res Public Health 2020;17(2):E445
23 Neiva KG, Catalfamo DL, Holliday S, Wallet SM, Pileggi R. Propolis decreases lipopolysaccharide-induced inflammatory mediators in pulp cells and osteoclasts. Dent Traumatol 2014;30(5):362–367
24 Saifee J, Qazi F, Farooqui W, Ahmed S. Effect of Chinese Propolis as an Inter-appointment Intracanal Medicament on Post-instrumentation Pain: A double blind randomized controlled trial. Mendeley Data, V2, 2019, doi: 10.17632/zshbgmgwsb.2
25 Zehra T. Agreement between two commonly used pulp tests in determining pulp vitality. Pakistan J Med Dent 2020; 9(2):26–31

26 American Association of Endodontists, Glossary of Endodontic Terms. 9th ed. American Association of Endodontists; 2016, Chicago, IL 60601
27 Relvas JB, Bastos MM, Marques AA. Garrido AD, Sponchiado EC Jr. Assessment of postoperative pain after reciprocating or rotary NiTi instrumentation of root canals: A randomized, controlled clinical trial. Clin Oral Investig 2016;20(8):1987–1993
28 Law AS, Nixdorf DR, Aguirre AM, et al; National Dental PBRN Collaborative Group. Predicting severe pain after root canal therapy in the National Dental PBRN. J Dent Res 2015; 94(3, Suppl):37S–43S
29 Çiçek E, Koçak MM, Koçak S, Sağlam BC, Türker SA. Postoperative pain intensity after using different instrumentation techniques: A randomized clinical study. J Appl Oral Sci 2017;25(1):20–26
30 Hou X-M, Su Z, Hou B-X. Post endodontic pain following single-visit root canal preparation with rotary vs reciprocating instruments: A meta-analysis of randomized clinical trials. BMC Oral Health 2017;17(1):86
31 Lautenbacher S, Peters JH, Heesen M, Scheel J, Kunz M. Age changes in pain perception: A systematic-review and meta-analysis of age effects on pain and tolerance thresholds. Neurosci Biobehav Rev 2017;75:104–113
32 Alaçam T, Tinaz AC. Interappointment emergencies in teeth with necrotic pulps. J Endod 2002;28(5):375–377
33 Gotler M, Bar-Gil B, Ashkenazi M. Postoperative pain after root canal treatment: A prospective cohort study. Int J Dent 2012;2012:310467
34 Akbar I, Iqbal A, Al-Omiri MK. Flare-up rate in molars with periapical radiolucency in one-visit vs two-visit endodontic treatment. J Contemp Dent Pract 2013;14(3):414–418
35 Onay EO, Ungor M, Yazici AC. The evaluation of endodontic flare-ups and their relationship to various risk factors. BMC Oral Health 2015;15(1):142
36 Mashyakhy M. Prevalence of a second root and canal in mandibular and maxillary canines in a Saudi Arabian population: a cone-beam computed tomography study. J Contemp Dent Pract 2019;20(7):773–777
37 Singh S, Pawar M. Root canal morphology of South Asian Indian mandibular premolar teeth. J Endod 2014;40(9):1338–1341