Turkish Online Journal of Qualitative Inquiry (TOJQI)
Volume 12, Issue 5, June 2021: 1686- 1695

Association of pain in relation to root canal treated tooth and incomplete obturation- retrospective study

Shreya Svitlana Anand [1] , Raghu Sandhya [2], Jaiganesh Ramamurthy[3]

Shreya Svitlana Anand
Saveetha Dental College and Hospitals,
Saveetha Institute of Medical and technical Sciences ,
Saveetha University,
Chennai, India
Mail Id : 151501029.sdc@saveetha.com

Raghu Sandhya
Reader , Department of Conservative Dentistry and Endodontics,
Saveetha Dental College and Hospitals,
Saveetha Institute of Medical and Technical sciences,
Saveetha University,
Chennai, India
Mail Id : sandhya.sdc@saveetha.com

Jaiganesh Ramamurthy
Professor and Head, Department of Periodontics,
Saveetha Dental College and Hospitals,
Saveetha Institute of Medical and Technical sciences,
Saveetha University,
Chennai, India
Mail Id : jaiganeshr@saveetha.com

ABSTRACT :

The retrospective study was conducted among patients visiting an institution in Chennai. The aim of the study was to evaluate the association of pain in relation to root canal treated teeth with incomplete obturation. The patients were assessed using the patient records from the university. Patients who reported with pain following root canal treatment were selected for the study . The etiology of pain post-endodontic treatment was evaluated. The prevalence of incomplete obturation as a radiographic finding was recorded to determine its association with the post-endodontic pain. The study was approved by the Institutional Review Board. The association of pain and no pain in the root canal treated tooth with incomplete obturation was found to have no significant difference [Pearson Chi- Square 0.087]. Considering the influence of age on the association with pain showed no or negligible relationship (Value – 0.375). Considering the influence of tooth on the association with pain showed positive relationship (Value – 0.005). Considering the influence of gender on the association with pain showed no or negligible relationship (value – 0.187). Hence an association of pain in root canal treated teeth with incomplete obturation was not established. However, prevalence of pain was higher in incompletely obturated lower posterior teeth followed by upper posterior teeth. Incidence of pain in relation to root canal treated teeth with incomplete obturation was higher in females among age groups 19 to 35 years .

Keywords : Root canal treatment, incomplete obturation , pain.

1.INTRODUCTION:

Disease of the pulp can be infectious or inflammatory [1]. Dental caries are easily detectable and reversible at an early stage. Once the incipient lesion proceeds to cavitation, the condition becomes irreversible. Hence it is necessary to prevent the progression of dental caries at an early stage, rather than to develop treatment strategies for progressive dental caries [2]. The major hurdle in root canal disinfection is the removal of the bacterial biofilm. The only way to achieve optimal removal is by following a proper irrigation protocol and final irrigants activation [3]. Rapid treatment can prevent long-term damage to the orofacial structures and save the teeth [4]. Use of an effective intracanal medicament will assist in the disinfection of the root canal system. Such medication should be effective throughout its period of application and penetrate the dentinal tubules, eliminating bacteria that may be present, with little toxicity to the periradicular tissues [5] Non carious loss of tooth structure in the cervical region is a very common clinical condition with the fact that the prevalence and severity of these lesions have been found to increase with age [6]. Dental erosion is defined as the loss of tooth structure due to a chemical process that does not involve bacteria [3]. Post endodontic pain is the most widely studied topic in endodontics. There are several factors associated with pain after root canal treatment [7]. One of the important aspects of root canal therapy is to control pain after treatment. Postoperative pain is an unwanted yet unfortunately common sensation after endodontic treatment [8]. Preoperative factors like acute exacerbation of chronic lesion, non-vital lesion, previously open tooth, unusual preoperative factors like acute exacerbation of chronic lesion, non-vital lesion, previously opened tooth, unusual canal anatomy, periapical; cyst, abscess or fracture teeth and also intraoperative factors like lack of use of rubber dam, irritating canal filling materials, incomplete irrigation, mechanical extrusion of filling materials and instruments, procedural complications, overlooked canals, incomplete obturation can give rise to more pain [9] [10] [11]. Amongst these some factors are frequently overlooked or missed by a busy practitioner. This can lead to unexpected postoperative complications, especially pain. The occurrence of postoperative pain of mild intensity is not a rare event even when endodontic treatment has followed acceptable standards [12]. The regulation of extracellular matrix in both physiologic and pathologic conditions is carried out by different protease systems which include cysteine proteinase, aspartic proteinase, serine proteinase, and metalloproteinases [13].

The primary aim of root canal treatment is to biomechanically prepare the canal with minimal or no discomfort and to hermetically seal it to aid recovery of insulted periapical tissues and to prevent post-operative pain (flare-up) [14]. Cleaning and shaping of root canal space is one of the most important and fundamental aspects of endodontic therapy. Better endodontic outcomes are achieved when preserving the original canal shape by using less invasive methods [15]. Instrumentation before measurement of root canal length will give rise to ledge formation [16]. Among the factors which influence incomplete obturation is incorrect measurement of root canal length [17]. Repeat radiographs are sometimes needed for correct length measurement. Use of endodontic microscopes can multiply the chances of success and overcome complications [18]. Calcification which is uncontrolled due to failure of enzyme pyrophosphatase, reduction in capillary permeability and blood supply causes calcifications. Teeth in which calcific deposits block access to the canal (s), treatment efforts are often hindered [19].

Incomplete chemo mechanical preparation can disrupt the balance within the microbial community by eliminating some inhibitory species and leaving behind other previously inhibited species, which can then overgrow [20]. As a result of the increase in microbial virulence, a previously asymptomatic case may become symptomatic. Mechanical instrumentation alone may not be sufficient to remove bacteria and necrotic tissue from root canals owing to the complex anatomy [21].

The final stage of endodontic treatment is to fill the entire root canal system and all its complex anatomic pathways completely and densely with non-irritating hermetic scaling agents. Total obliteration of the canal space and perfect sealing of the apical foramen at the dentin-cementum junction and accessory canals at locations other than the root apex with an inert, dimensionally stable, and biologically compatible material are the goals for consistently successful endodontic treatment [22].Previously our team has a rich experience in working on various research projects across multiple disciplines The [22–24][25–36]. The aim of the study was to evaluate the association of pain in relation to root canal treated teeth with incomplete obturation.

2.MATERIALS AND METHOD :

Study Setting

The study was conducted with the approval of the Institutional Ethics Committee [SDC/SIHEC/2020/DIASDATA/0619-0320]. The study consisted of one reviewer, one assessor and one guide .

Study Design

The study was designed to include all patients who reported with pain following root canal treatment. The patients who did not fall into this inclusion criteria were excluded.

Sampling Technique

The study was based on a non probability consecutive sampling method. To minimise sampling bias, all case sheets of patients who reported with pain following root canal treatment were reviewed and included. The etiology of pain post-endodontic treatment was evaluated. The prevalence of incomplete obturation as a radiographic finding was recorded to determine its association with the post-endodontic pain.

Data Collection and Tabulation

Data Collection was done using the patient database with the timeframe work 01 June 2019 and 31 march 2020. About 145 case sheets were reviewed and those fitting under the inclusion criteria were included. Cross verification was done with the help of Photographs and radiographic evidence. To minimise sampling bias all data were included. The exclusion criteria was patients with systemic illness. Data was downloaded from DIAS and imported to Excel, Tabulation was done. The values were tabulated and analysed.

Statistical Analysis

Descriptive statistics were performed using SPSS by IBM on the tabulated values. Chi-Square test was performed and the p value was determined to evaluate the significance of the variables it was used to evaluate the association between the age and gender with the type of treatment in the affected tooth. The results were obtained in the form of graphs and tables.

3.RESULTS AND DISCUSSION :

From the patient record a total of 145 cases having incomplete obturation in the root canal treated tooth were retrieved.

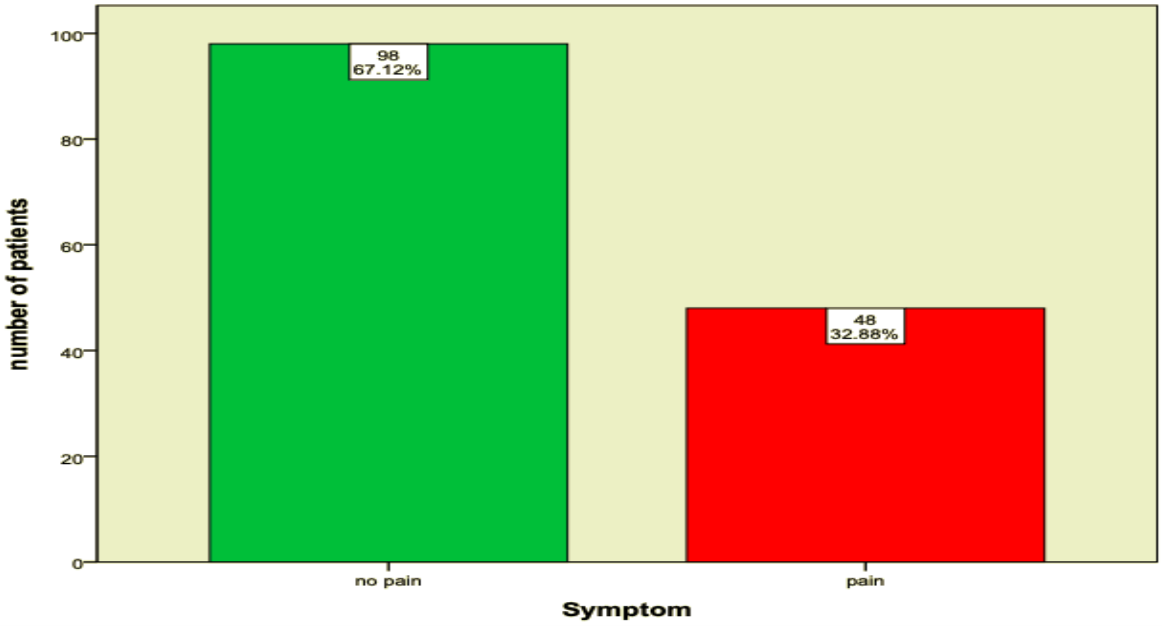

Figure 1: Bar chart showing distribution of patients with and without pain in relation to incompletely obturated teeth. X axis denotes the distribution of patients based on symptom of the incompletely obturated tooth and Y axis denotes the number of patients with incompletely obturated teeth. Among the patients with incompletely obturated teeth 67.58% of the study population presented with no pain (green) and only 33.10% of the study population presented with pain (red). [Pearson Chi square value - 143.73 , p value- 0.087, insignificant]. Hence , there was no statistically significant association between symptom and incomplete obturation of teeth .

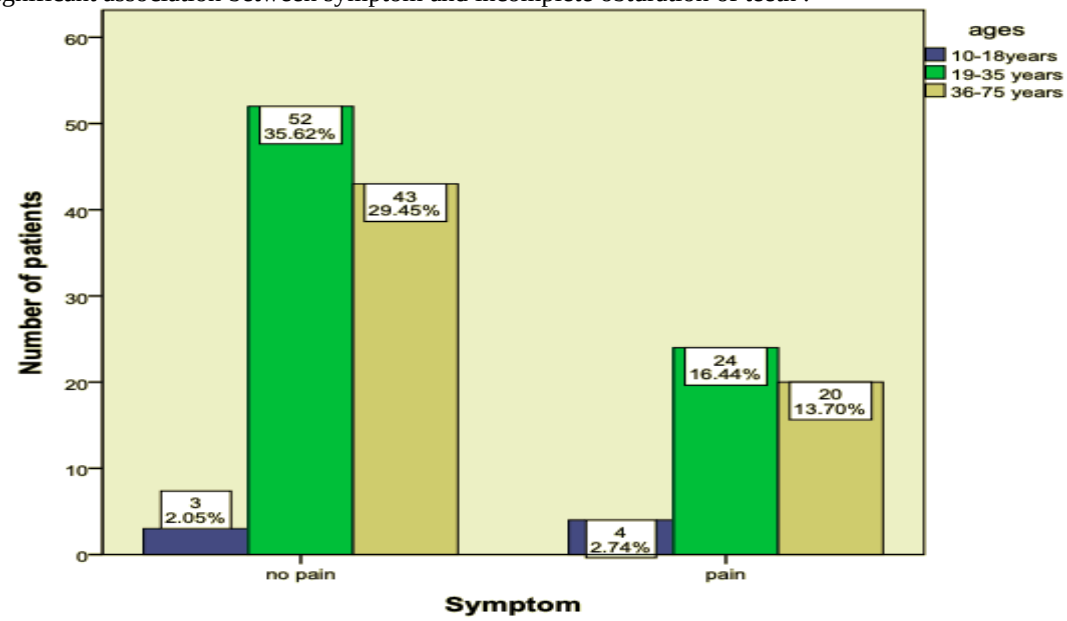

Figure 2: Bar chart showing association between age and symptom of incompletely obturated teeth. X axis denotes the distribution of symptom and Y axis represents number of patients with incomplete obturation. Maximum number of patients exhibiting pain belong to the age group 19 to 35 years (green) and the minimum number of patients exhibiting pain belong to the age group 10 to 18 years (blue). [Pearson Chi square value - 1.962 , p value- 0.375, insignificant]. However , there was no significant association between age and symptom exhibited by the patient .

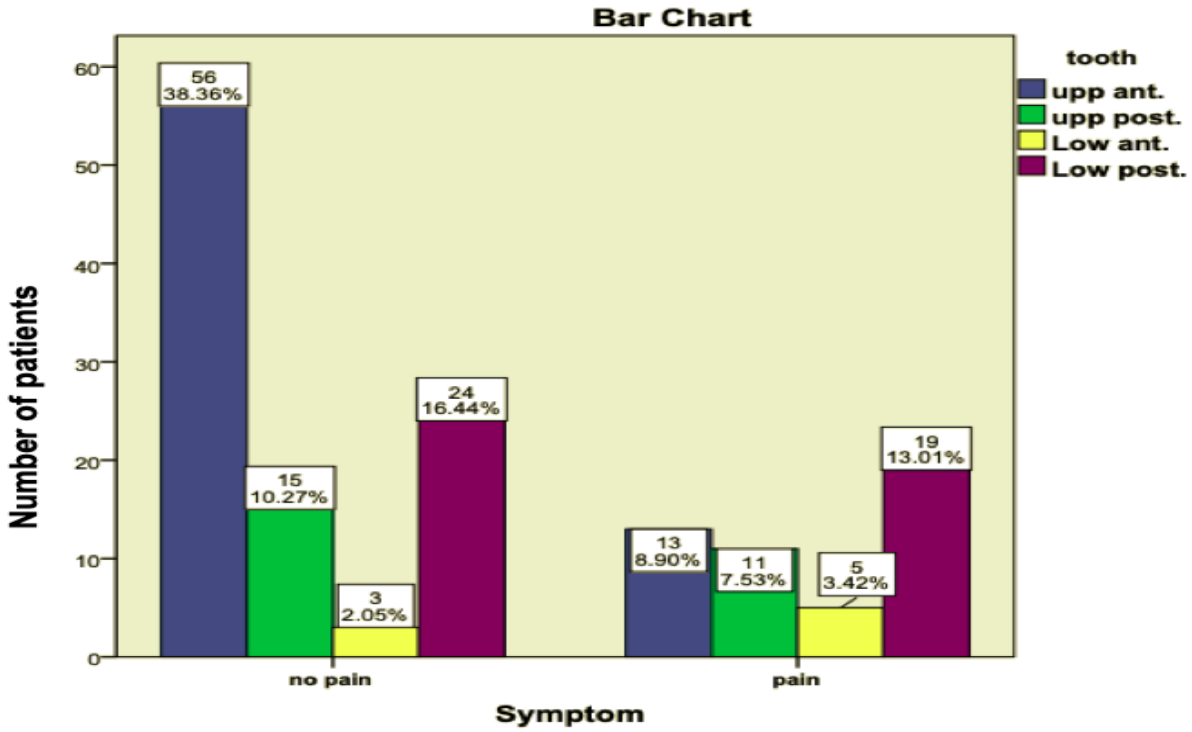

Figure 3: Bar chart showing association between arch wise distribution of tooth and symptom among incompletely obturated teeth. X axis denotes distribution of symptom among teeth with incomplete obturation and Y axis denotes the number of patients with incomplete obturation. Among patients exhibiting pain with incompletely obturated teeth, the most affected teeth belonged to lower posteriors (violet)(13.01%).[Pearson Chi square value - 12.881, p value- 0.005, statistically significant]. Hence , there was no significant association between arch wise distribution of tooth and symptom exhibited by the patient .

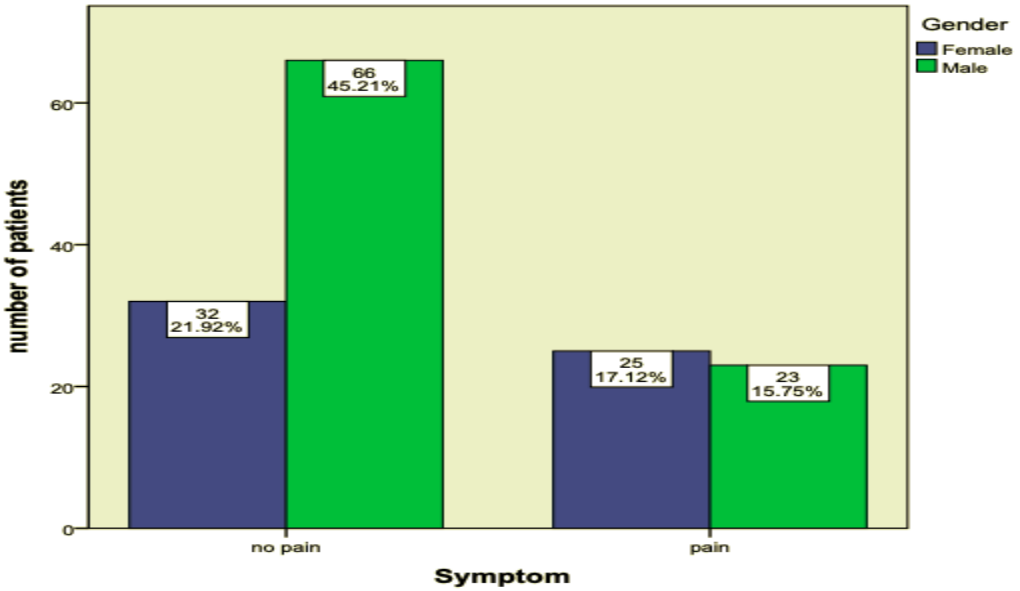

Figure 4. Bar chart showing association between symptom and gender among patients with incompletely obturated teeth. X axis denotes the distribution of pain and Y axis denotes the number of patients with incompletely obturated teeth. Maximum number of patients exhibiting pain belongs to the female (blue) gender (17.12%) [Pearson Chi square

value - 5.111, p value- 0.184, insignificant]. However , there was no significant association between symptom and gender of the patients with incompletely obturated teeth.

The association of pain and no pain in the root canal treated tooth with incomplete obturation was found to have no significant difference [Pearson Chi- Square 0.087]. Considering the influence of age on the association with pain showed no or negligible relationship (Value – 0.116). Considering the influence of tooth on the association with pain showed positive relationship (Value – 0.005). Considering the influence of gender, no. of male patients associated with and without pain were 23 (25.8%)and 66 (74.2 %) respectively. No. of female patients with and without pain were 25(43.9 %) and 32(56.1%) respectively. Influence of gender on the association with and without pain showed no or negligible relationship (value – 0.187).

Every research is limited in one way or the other and the present one is by no means an exception. As a cross sectional study, the study lacks the ability to establish temporal relationships. Within the limits of the study, 32.4 % of the study population reported with pain and upon inspection incomplete obturation of the canal was discovered. However, upon statistical analysis, the association of pain and no pain in the root canal treated tooth with incomplete obturation was found to have no significant difference [Pearson Chi- Square 0.087]. Complete debridement, disinfection of the pulpal space are considered to be essential for predictable long term success in endodontic treatment [23]. According to El Deeb at al, nearly 60% of endodontic failure is apparently caused by incomplete obliteration of the canal space [24]. Schilder emphasized the distinction between overfilling and underfilling and between overextension and underextension, In underfilling, the canal space is incompletely filled, leaving voids as potential areas of decontamination and infection. [25]. Although there is no direct correlation with classic success/ failure literature, it is interesting to note that there were several areas of findings agreement. Certainly the factors associated with failures and retreatments are multivariate. Overfilling the canal space seems significantly less of a problem than incomplete or poor obturation quality . Incomplete obturation in the Washington study (59%), in the Petersson study (50%), and poor obturation quality noted in this investigation (65%) were all high percentage negative influencing factors [26]. Flare-ups are frequent complications which are disturbing to both patients and clinicians and are the cause of the majority of endodontic emergencies resulting in unscheduled visits for treatment. A flare-up is characterized by pain and/or swelling that may arise following initial debridement of the root canals or even after obturation. Among the various factors that play a role in the incidence of flare-ups and in endodontic practice , one of the causes is inadequate obturation [27].The incidence of postoperative pain following endodontic treatment was reported to be from 3% to 58% [28]. Assessment of gender influence on pain experienced by patients, it was found that more females experienced pain due to incomplete obturation compared to males. However, statistical analysis considering the influence of gender on the association with pain showed no or negligible relationship (value – 0.187). But the result of the study is in agreement with a longitudinal study which was done to assess the prevalence of post-obturation pain in patients undergoing root canal treatment and to evaluate the influence of factors affecting pain, where 40.2% of patients reported with pain after treatment. The patient's gender was found to be a prognostic determinant. Females were found to have an increased rate of flare-ups than males [29 37]. Another factor, the age of the patient was assessed to identify if any relationship existed. The influence of age on the association with pain showed no or negligible relationship (Value – 0.116). This is in agreement with a previous study, where age did not have any significant influence on the incidence of post-incomplete obturation pain [30]. There are numerous factors which can account for pain either during or after endodontic treatment. Some of these factors such as unusual canal anatomy, presence of extra canal, lateral canals, variations in location of a canal opening, acute exacerbation of chronic conditions are not entirely under the control of the dental surgeon. However there are other factors for success related to choice of irrigant, intracanal medicament, instruments, instrumentation techniques, obturation techniques, obturation materials, storage medium, post endodontic restoration which are very much under the control of the dental surgeon [17,38,39].To be forewarned is to be fore-armed. Precautions, approaches and effort to discuss can decide the level of success or failure in endodontics.Our institution is passionate about high quality evidence based research and has excelled in various fields ([40–50].

4.CONCLUSION :

Within the limitations of this study, association of pain in root canal treated teeth with incomplete obturation was not established. However, prevalence of pain was higher in incompletely obturated lower posterior teeth followed by upper posterior teeth. Incidence of pain in relation to root canal treated teeth with incomplete obturation is higher in females among age group 19 to 35 years .

5.ACKNOWLEDGEMENT :

Nil.

6.CONFLICT OF INTEREST :

The authors declare that they have no conflict of interest.

7. REFERENCES :

1. Janani K, Palanivelu A, Sandhya R. Diagnostic accuracy of dental pulse oximeter with customized sensor holder, thermal test and electric pulp test for the evaluation of pulp vitality: an in vivo study. Brazilian Dental Science [Internet]. 2020; Available from: https://200.145.25.12/index.php/cob/article/view/1805

2. Rajendran R, Kunjusankaran RN. Comparative Evaluation of Remineralizing Potential of a Paste Containing Bioactive Glass and a Topical Cream Containing Casein Phosphopeptide …. Pesqui Bras Odontopediatria Clin Integr [Internet]. 2019; Available from: http://www.scielo.br/scielo.php?pid=S1983-46322019000100364&script=sci_arttext

3. Mahalakshmi Nandakumar IN. Comparative evaluation of grape seed and cranberry extracts in preventing enamel erosion: An optical emission spectrometric analysis. J Conserv Dent [Internet]. 2018; Available from: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6161533/

4. Jose J, Subbaiyan H. Different Treatment Modalities followed by Dental Practitioners for Ellis Class 2 Fracture–A Questionnaire-based Survey. Open Dent J [Internet]. 2020; Available from: https://opendentistryjournal.com/VOLUME/14/PAGE/59/FULLTEXT/

5. Manohar MP, Sharma S. A survey of the knowledge, attitude, and awareness about the principal choice of intracanal medicaments among the general dental practitioners and …. Indian J Dent Res [Internet]. 2018; Available from: http://www.ijdr.in/article.asp?issn=0970-9290;year=2018;volume=29;issue=6;spage=716;epage=720;aulast=Manohar

6. Hussainy SN, Nasim I, Thomas T. Clinical performance of resin-modified glass ionomer cement, flowable composite, and polyacid-modified resin composite in noncarious cervical lesions: One …. J Conserv Dent [Internet]. 2018; Available from: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6161514/

7. Jariwala SP, Goel BR. Pain in endodontics: causes, prevention and management. Endodontology. 2001;

8. Ramamoorthi S, Nivedhitha MS. Comparative evaluation of postoperative pain after using endodontic needle and EndoActivator during root canal irrigation: a randomised controlled trial. Aust Endod J [Internet]. 2015; Available from: https://onlinelibrary.wiley.com/doi/abs/10.1111/aej.12076

9. Seltzer S, Bender IB, Ehrenreich J. Incidence and duration of pain following endodontic therapy: relationship to treatment with sulfonamides and to other factors. Oral Surgery, Oral Medicine [Internet]. 1961; Available from: https://www.oooojournal.net/article/0030-4220(61)90476-5/pdf

10. Bergenholtz G, Lekholm U, Milthon R, Heden G, Ödesjö B, Engström B. Retreatment of endodontic fillings. Eur J Oral Sci. 1979 Jun;87(3):217–24.

11. Grossman LI, Shepard LI. Roentgenologic and clinical evaluation of endodontically treated teeth. Oral Surgery, Oral [Internet]. 1964; Available from: https://www.oooojournal.net/article/0030-4220(64)90510-9/pdf

12. Siqueira JF Jr, Barnett F. Interappointment pain: mechanisms, diagnosis, and treatment. Endodontic Topics [Internet]. 2004; Available from: https://onlinelibrary.wiley.com/doi/abs/10.1111/j.1601-1546.2004.00062.x

13. Teja KV, Ramesh S, Priya V. Regulation of matrix metalloproteinase-3 gene expression in inflammation: A molecular study. J Conserv Dent [Internet]. 2018; Available from: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6249951/

14. Christopher U, Emmanuel A. Flare-up incidence and related factors in adults. J Dent Oral Hyg [Internet]. 2010; Available from: https://www.unn.edu.ng/wp-content/uploads/2015/12/09e4150c108216df58000000pdf.pdf

15. Ramanathan S, Solete P. Cone-beam Computed Tomography Evaluation of Root Canal Preparation using Various Rotary Instruments: An in vitro Study. J Contemp Dent Pract [Internet]. 2015; Available from: https://europepmc.org/abstract/med/26718293

16. Ingle JI, Bakland LK, Baumgartner JC. Ingle's endodontics/John I. Ingle, Leif K. Bakland, J. Craig Baumgartner. Hamilton, Ont.: BC Decker,; 2008.

17. Hargreaves KM, Berman LH. Cohen's pathways of the pulp expert consult. 2015; Available from: https://books.google.com/books?hl=en&lr=&id=qQzhCgAAQBAJ&oi=fnd&pg=PP1&dq=8.%09Hargreaves,+Kenneth+M.,+and+Louis+H.+Berman.+Cohen%27s+pathways+of+the+pulp+expert+consult.+Elsevier+Health+Sciences,+2015&ots=aephpLG70C&sig=XbfFXLGiLYZsgzowvb9jl6P4vjw

18. Kim S, Kratchman S. Modern Endodontic Surgery Concepts and Practice: A Review. J Endod. 2006 Jul 1;32(7):601–23.

19. Kumar D, Antony S. Calcified Canal and Negotiation-A Review. J Pharm Technol [Internet]. 2018; Available from: http://www.indianjournals.com/ijor.aspx?target=ijor:rjpt&volume=11&issue=8&article=088

20. Sundqvist G. Ecology of the root canal flora. J Endod [Internet]. 1992; Available from: https://www.sciencedirect.com/science/article/pii/S0099239906808423

21. Siddique R, Sureshbabu NM. Qualitative and quantitative analysis of precipitate formation following interaction of chlorhexidine with sodium hypochlorite, neem, and tulsi. Journal of [Internet]. 2019; Available from: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6385576/

22. Hafeez N, Others. Accessory foramen in the middle cranial fossa. Research Journal of Pharmacy and Technology. 2016;9(11):1880.

23. Krishnan RP, Ramani P, Sherlin HJ, Sukumaran G, Ramasubramanian A, Jayaraj G, et al. Surgical Specimen Handover from Operation Theater to Laboratory: A Survey. Ann Maxillofac Surg. 2018 Jul;8(2):234–8.

24. Somasundaram S, Ravi K, Rajapandian K, Gurunathan D. Fluoride content of bottled drinking water in Chennai, Tamilnadu. J Clin Diagn Res. 2015;9(10):ZC32.

25. Felicita AS, Sumathi Felicita A. Orthodontic extrusion of Ellis Class VIII fracture of maxillary lateral incisor – The sling shot method [Internet]. Vol. 30, The Saudi Dental Journal. 2018. p. 265–9. Available from: http://dx.doi.org/10.1016/j.sdentj.2018.05.001

26. Kumar S, Rahman R. Knowledge, awareness, and practices regarding biomedical waste management among undergraduate dental students. Asian J Pharm Clin Res. 2017 Aug 1;10(8):341.

27. Gurunathan D, Shanmugaavel AK. Dental neglect among children in Chennai. J Indian Soc Pedod Prev Dent. 2016 Oct 1;34(4):364.

28. Sneha S, Others. Knowledge and awareness regarding antibiotic prophylaxis for infective endocarditis among undergraduate dental students. Asian Journal of Pharmaceutical and Clinical Research. 2016;154–9.

29. Dhinesh B, Isaac JoshuaRamesh Lalvani J, Parthasarathy M, Annamalai K. An assessment on performance, emission and combustion characteristics of single cylinder diesel engine powered by Cymbopogon flexuosus biofuel. Energy Convers Manage. 2016 Jun 1;117:466–74.

30. Choudhari S, Thenmozhi MS. Occurrence and Importance of Posterior Condylar Foramen. Laterality.

2016;8:11–43.

31. Paramasivam A, Vijayashree Priyadharsini J, Raghunandhakumar S. N6-adenosine methylation (m6A): a promising new molecular target in hypertension and cardiovascular diseases. Hypertens Res. 2020 Feb;43(2):153–4.

32. Wu F, Zhu J, Li G, Wang J, Veeraraghavan VP, Krishna Mohan S, et al. Biologically synthesized green gold nanoparticles from Siberian ginseng induce growth-inhibitory effect on melanoma cells (B16). Artif Cells Nanomed Biotechnol. 2019 Dec;47(1):3297–305.

33. Palati S, Ramani P, Shrelin H, Sukumaran G, Ramasubramanian A, Don KR, et al. Knowledge, Attitude and practice survey on the perspective of oral lesions and dental health in geriatric patients residing in old age homes [Internet]. Vol. 31, Indian Journal of Dental Research. 2020. p. 22. Available from: http://dx.doi.org/10.4103/ijdr.ijdr_195_18

34. Saravanan M, Arokiyaraj S, Lakshmi T, Pugazhendhi A. Synthesis of silver nanoparticles from Phenerochaete chrysosporium (MTCC-787) and their antibacterial activity against human pathogenic bacteria. Microb Pathog. 2018 Apr;117:68–72.

35. GovinDaraju L, Gurunathan D. Effectiveness of Chewable Tooth Brush in Children-A Prospective Clinical Study. J Clin Diagn Res. 2017;11(3):ZC31.

36. Vijayakumar Jain S, Muthusekhar MR, Baig MF, Senthilnathan P, Loganathan S, Abdul Wahab PU, et al. Evaluation of Three-Dimensional Changes in Pharyngeal Airway Following Isolated Lefort One Osteotomy for the Correction of Vertical Maxillary Excess: A Prospective Study. J Maxillofac Oral Surg. 2019 Mar;18(1):139–46.

37. Teja KV, Ramesh S. Shape optimal and clean more. Saudi Endodontic Journal [Internet]. 2019; Available from: http://www.saudiendodj.com/article.asp?issn=1658-5984;year=2019;volume=9;issue=3;spage=235;epage=236;aulast=Teja

38. Rajakeerthi R, Ms N. Natural Product as the Storage medium for an avulsed tooth–A Systematic Review. Cumhuriyet Dental Journal [Internet]. 2019; Available from: https://dergipark.org.tr/en/pub/cumudj/issue/45584/525182

39. Ravinthar K. Recent Advancements in Laminates and Veneers in Dentistry. Research Journal of Pharmacy and Technology [Internet]. 2018; Available from: http://www.indianjournals.com/ijor.aspx?target=ijor:rjpt&volume=11&issue=2&article=070

40. Vijayashree Priyadharsini J. In silico validation of the non-antibiotic drugs acetaminophen and ibuprofen as antibacterial agents against red complex pathogens. J Periodontol. 2019 Dec;90(12):1441–8.

41. Pc J, Marimuthu T, Devadoss P. Prevalence and measurement of anterior loop of the mandibular canal using CBCT: A cross sectional study. Clin Implant Dent Relat Res [Internet]. 2018; Available from: https://europepmc.org/article/med/29624863

42. Ramesh A, Varghese S, Jayakumar ND, Malaiappan S. Comparative estimation of sulfiredoxin levels between chronic periodontitis and healthy patients - A case-control study. J Periodontol. 2018 Oct;89(10):1241–8.

43. Ramadurai N, Gurunathan D, Samuel AV, Subramanian E, Rodrigues SJL. Effectiveness of 2% Articaine as an anesthetic agent in children: randomized controlled trial. Clin Oral Investig. 2019 Sep;23(9):3543–50.

44. Sridharan G, Ramani P, Patankar S, Vijayaraghavan R. Evaluation of salivary metabolomics in oral leukoplakia and oral squamous cell carcinoma. J Oral Pathol Med. 2019 Apr;48(4):299–306.

45. Ezhilarasan D, Apoorva VS, Ashok Vardhan N. Syzygium cumini extract induced reactive oxygen species-mediated apoptosis in human oral squamous carcinoma cells. J Oral Pathol Med. 2019 Feb;48(2):115–21.

46. Mathew MG, Samuel SR, Soni AJ, Roopa KB. Evaluation of adhesion of Streptococcus mutans, plaque accumulation on zirconia and stainless steel crowns, and surrounding gingival inflammation in primary molars: Randomized controlled trial. Clin Oral Investig. 2020;1–6.

47. Samuel SR. Can 5-year-olds sensibly self-report the impact of developmental enamel defects on their quality of life? Int J Paediatr Dent. 2021 Mar;31(2):285–6.

48. R H, Hannah R, Ramani P, Ramanathan A, R JM, Gheena S, et al. CYP2 C9 polymorphism among patients with oral squamous cell carcinoma and its role in altering the metabolism of benzo[a]pyrene [Internet]. Vol. 130, Oral Surgery, Oral Medicine, Oral Pathology and Oral Radiology. 2020. p. 306–12. Available from: http://dx.doi.org/10.1016/j.oooo.2020.06.021

49. Chandrasekar R, Chandrasekhar S, Sundari KKS, Ravi P. Development and validation of a formula for objective assessment of cervical vertebral bone age. Prog Orthod. 2020 Oct 12;21(1):38.

50. Vijayashree Priyadharsini J, Smiline Girija AS, Paramasivam A. In silico analysis of virulence genes in an emerging dental pathogen A. baumannii and related species. Arch Oral Biol. 2018 Oct;94:93–8.