International Journal of Dentistry and Oral Science (IJDOS)
ISSN: 2377-8075

Postoperative Pain Associated With Resin And Bioceramic Based Sealers: A Systematic Review

Review Article

Sowmya[1], Nivedhitha MS[2*]

[1] Department of Conservative Dentistry and Endodontics, Saveetha Dental College and Hospitals, Saveetha Institute of Medical and Technical Sciences, Saveetha University, Chennai, India.
[2] Professor and Head, Department of Conservative Dentistry and Endodontics, Clinical Genetics Lab, Saveetha Dental College and Hospitals, Saveetha Institute of Medical and Technical Sciences, Saveetha University, Chennai - 600077, India.

Abstract

Introduction: The main aim of root canal treatment is to eliminate the necrotic pulp tissue, debris and microorganisms from the root canal and also to disinfect and provide a three dimensional obturation.[1] All these steps should be performed with the aim of minimal postoperative discomfort. Postoperative pain is usually provoked by various factors- mechanical, chemical, presence of bacteria within the anatomical complexity of the canal space, iatrogenic and treatment related factors. [2] The treatment related factors include poor estimation of working length, improper instrumentation, choice of sealer and extrusion of sealers/ obturating materials. [3]

The choice of sealers also plays a role in the occurrence of postoperative pain. [4] Sealers placed within the root canal tend to interfere with the surrounding periodontal tissues via accessory canals or lateral foramina and cause a local inflammatory reaction which can subsequently cause postoperative pain. [5] The commonly used sealers are zinc oxide eugenol based sealers, resin based sealers and of late bioceramic sealers have found a clinical significance. [6] This can be attributed to the release of biologically active substances and odontoblastic differentiation which improved the outcome of the treatment in a clinical setting. [7] But the resin based sealers have a higher bonding capacity compared to bioceramic sealers. However, it has been suggested that bioceramic sealers are less cytotoxic compared to resin based sealers. [8] The current systematic review focuses on the previous clinical trials performed on the clinical characteristics of resin based and bioceramic sealers in the occurrence of postoperative pain.

Aim: The aim of this study is to compare the incidence of postoperative pain associated with the use of Resin based or Bioceramic sealers in endodontically treated teeth.

Selection criteria: The studies were selected if the studies were in vivo studies done as clinical trials.

Data collection and Analysis: All the studies included were based on the data extraction and analysis of the studies for quality and publication bias. The data collection form was customized. The outcome measure was to comparatively evaluate the incidence of postoperative pain after using bioceramic and resin based sealers.

Results: Six studies were identified and included in the systematic review based on Inclusion and exclusion criteria. The quality assessment was done and the level of evidence was moderate.

Conclusion: With the available evidence from the included studies, the quality of the clinical trials was moderate. Most of the included studies did follow a common methodology to assess the incidence of postoperative pain. The results of five included studies concluded that there was no significant difference in the pain level when the different sealers were used. More number of clinical trials adhering to the correct method of randomisation, allocation concealment and blinding have to be carried out to arrive at a definitive conclusion regarding the occurrence of postoperative pain following the usage of resin based and bioceramic sealers in endodontically treated teeth.

Keywords: Bioceramic Sealer; Resin Based Sealers; Postoperative Pain.

***Corresponding Author**:
Nivedhitha MS,
Professor and Head, Department of Conservative Dentistry and Endodontics, Clinical Genetics Lab, Saveetha Dental College and Hospitals, Saveetha Institute of Medical and Technical Sciences, Saveetha University, Chennai - 600077, India.
Tel: 9840912367
E-mail: nivedhitha@saveetha.com

Received: May 04, 2021
Accepted: July 29, 2021
Published: August 02, 2021

Citation: Sowmya, Nivedhitha MS. Postoperative Pain Associated With Resin And Bioceramic Based Sealers: A Systematic Review. *Int J Dentistry Oral Sci.* 2021;8(8):3613-3619. doi: http://dx.doi.org/10.19070/2377-8075-21000739

Introduction

Postoperative pain after endodontic treatment is uninvited but it may manifest in a few hours to a few days after treatment.[9] Different studies show that the postoperative pain ranges from 3% to 60%.[10] Pain can occur due to mechanical, chemical or microbial causes.[11] There are umpteen treatment related factors which are responsible for postoperative pain, few of them being loss of working length, instrumentation technique, overzealous use of intracanal irrigants, forceful instrumentation and choice of sealers.[12] Sealers tend to interact with the periapical tissues and surrounding periodontal tissues and thus might interfere with the healing process. [13] They tend to extrude through the periapex, which can cause local inflammatory reactions.[12] The composition of sealers also markedly influence the inflammatory reaction. [14]

Different types of sealers are commonly used in endodontics. The most commonly used ones are zinc oxide eugenol based sealers and resin based sealers. Of late calcium phospho silicate based sealers have emerged to be successful in endodontics. [15] The two major advantages of bioceramic sealers are its biocompatibility and good sealer-to-dentin bonding.[16] But the major disadvantage of bioceramic sealers is the difficulty in removing the sealer after it has set as indicated in post space preparation or retreatment.[17] Resin based sealers have good sealing ability and are biocompatible with moderate antimicrobial properties.[18]

Previously our team has a rich experience in working on various research projects across multiple disciplines [19-33] Now the growing trend in this area motivated us to pursue this project.

Aim

The aim of this review is to compare the incidence of postoperative pain using bioceramic and resin based sealers in endodontically treated teeth.

Research question

Is there any difference in the incidence of postoperative pain after using resin based or bioceramic sealers in endodontically treated teeth?

Null Hypothesis

There is no significant difference in the incidence of postoperative pain using bioceramic sealers and resin based sealers in endodontically treated teeth.

Alternate hypothesis

There is a significant difference in the incidence of postoperative pain using bioceramic and resin based sealers in endodontically treated teeth.

PICO

P - Endodontically treated teeth
I - Bioceramic sealer
C - Resin based Sealer
O - Postoperative pain

Materials and Methods

Sources used

Detailed search strategies were carried out on the following databases.

- PubMed
- Pubmed advanced search
- Scopus database
- Cochrane database

Language restrictions

No limits and language restrictions were applied during the electronic search to include the search phase of the systematic review. No time restriction was applied.

Hand search

Additionally, hand searching was done in the following journals

- Clinical oral investigations
- E Cronicon open access journal

Inclusion criteria

Criteria for considering studies for this review:

- Studies which compared the bioceramic sealers and resin based sealers in postoperative pain.
- Clinical trials, prospective studies.

Exclusion criteria

The following studies were excluded:

- Case reports
- Case series
- In vitro studies
- Studies comparing other sealers

Results And Discussion

Description of studies

The search identified 6 publications which were relevant to the title. A total of 6 publications that fulfilled the criteria were included in this review.[Table 1]

Risk of bias of Included studies

The assessment for the four main methodological quality items are shown in the table. The study was assessed to have a 'High risk of bias' if it did not record a 'yes' in three or more of the four main categories, 'Moderate risk of bias' if it did not record yes in two out of the four categories and 'Low risk of bias' if randomization, allocation concealment, assessor blinding and completeness to follow up were considered adequate.[Table 2-6]

Table 1. Representing theGeneral information of selected studies (Data Extraction).

Author/ Year/ Country	Sample size (Pts/ Teeth)	Tooth type	Type of sealer		Method to assess Postoperative pain	Statistical analysis	Results	Conclusion
			Resin based sealer	Bioceramic sealer				
Indre Graunaite, 2018, Lithuania	61/ 122	Single rooted teeth with asymptomatic apical periodontitis	AH Plus	Total Fill	VAS at 24h, 48h, 72h and 7 days	Wilcoxon test	P>0.05 There was no statistically significant difference between the tested root canal sealers	AH Plus and Total Fill perform similarly in terms of the occurrence and intensity of postoperative pain in teeth with AAP.
Ana Paz, 2018, Portugal	30/30		AH Plus + Continuous wave of condensation Resin sealer + cold lateral condensation	Bioceramic + single cone technique	VAS at 24, 48, 72, 96, 120, 144 and 168h	Kruskal Wallis	Single cone + Bioceramic referred post-operative pain more frequently than resin sealer + CWC or Lateral condensation	Bioceramic sealer comparatively presented with postoperative pain compared to resin sealer.
Ayfer Atav Ates, 2018, Turkey	160/160		AH plus sealer	iRoot SP sealer	VAS at 6, 12, 24 and 72 h	One way ANOVA with Bonferroni test	Results showed that there was no significant difference between groups	The use of different sealers did not significantly affect pain levels.
Braulio Fonseca, 2019, Brazil	64/64	Single rooted maxillary teeth with necrotic pulps	AH Plus	Sealer Plus BC	VAS at 24h, 48h, 72h and 7 days	Chi square and Mann-Whitney test	p>0.05 No significant difference in the postoperative pain	The average pain level was similar in both groups.
T. Aslan, 2020, Turkey	90/ 271	1st and 2nd Molar with asymptomatic irreversible pulpitis	2 (Endoseal MTA and AH plus sealer)	Endosequence BC sealer	VAS at 6,12,24 and 48h And 3,4,5,6 &7 days	Kruskal Wallis test	There were no significant differences among the groups- P>0.05	The sealers tested in this study had similar levels of postoperative pain.
Gabriel et al, 2021, Singapore	168/168	Anterior, Premolar and molar teeth	AH plus	Total fill BC sealer	5 point Likert scale	Fisher's exact test	Results showed that there was no post-obturation pain difference between the two sealers.	There was no significant difference in pain experience between teeth filled using AH plus or TotalFill BC sealer.

Table 2. Representing the Study design and Outcome.

Author/ Year/ Country	Sample size (Pts/ Teeth)	Tooth type	Type of sealer		Method to assess Postoperative pain	Statistical analysis	Results	Conclusion
			Resin based sealer	Bioceramic sealer				
Indre Graunaite, 2018, Lithuania	61/ 122	Single rooted teeth with asymptomatic apical periodontitis	AH Plus	Total Fill	VAS at 24h, 48h, 72h and 7 days	Wilcoxon test	P>0.05 There was no statistically significant difference between the tested root canal sealers	AH Plus and Total Fill perform similarly in terms of the occurrence and intensity of postoperative pain in teeth with AAP.
Ana Paz, 2018, Portugal	30/30		AH Plus + Continuous wave of condensation Resin sealer + cold lateral condensation	Bioceramic + single cone technique	VAS at 24, 48, 72, 96, 120, 144 and 168h	Kruskal Wallis	Single cone + Bioceramic referred post-operative pain more frequently than resin sealer + CWC or Lateral condensation	Bioceramic sealer comparatively presented with postoperative pain compared to resin sealer.
Ayfer Atav Ates, 2018, Turkey	160/160		AH plus sealer	iRoot SP sealer	VAS at 6, 12, 24 and 72 h	One way ANOVA with Bonferroni test	Results showed that there was no significant difference between groups	The use of different sealers did not significantly affect pain levels.
Braulio Fonseca, 2019, Brazil	64/64	Single rooted maxillary teeth with necrotic pulps	AH Plus	Sealer Plus BC	VAS at 24h, 48h, 72h and 7 days	Chi square and Mann-Whitney test	p>0.05 No significant difference in the postoperative pain	The average pain level was similar in both groups.
T. Aslan, 2020, Turkey	90/ 271	1st and 2nd Molar with asymptomatic irreversible pulpitis	2 (Endoseal MTA and AH plus sealer)	Endosequence BC sealer	VAS at 6,12,24 and 48h And 3,4,5,6 &7 days	Kruskal Wallis test	There were no significant differences among the groups- P>0.05	The sealers tested in this study had similar levels of postoperative pain.
Gabriel et al, 2021, Singapore	168/168	Anterior, Premolar and molar teeth	AH plus	Total fill BC sealer	5 point Likert scale	Fisher's exact test	Results showed that there was no post-obturation pain difference between the two sealers.	There was no significant difference in pain experience between teeth filled using AH plus or TotalFill BC sealer.

Table 3. Evidence level of significant studies.

Author	Year	Study design	Level of evidence
Indre Graunite et al	2018	Split mouth Randomized controlled clinical trial	1b
Ana Paz et al	2018	Prospective clinical study	2b
Ayfer Atav Ates et al	2018	Randomized controlled clinical trial.	1b
Braulio Fonseca et al	2019	Prospective clinical study	1b
T. Aslan et al	2020	Randomized controlled clinical trial	1b
Gabriel et al	2021	Randomized clinical trial	1b

Table 4. Risk of bias- Major criteria.

No	Author	Year	Randomization	Allocation concealment	Assessor blinding	Dropouts described	Risk of bias
1	Indre Graunite et al	2018	No	No	Yes	Yes	Moderate
2	Ana Paz et al	2018	No	No	No	No	High
3	Ayfer Atav Ates et al	2018	Yes	Yes	No	No	Moderate
4	Braulio Fonseca et al	2019	Yes	Yes	Yes	Yes	Low
5	T. Aslan et al	2020	Yes	No	No	Yes	Moderate
6	Gabriel et al	2021	Yes	Yes	Yes	Yes	Low

Table 5. Risk of bias: Minor criteria.

No	Author	Year	Sample justified	Baseline comparison	I/E Criteria	Method error
1	Indre Graunite et al	2018	Yes	Yes	yes	No
2	Ana Paz et al	2018	No	No	No	No
3	Ayfer Atav Ates et al	2018	Yes	No	No	No
4	Braulio Fonseca et al	2019	Yes	Yes	No	No
5	T. Aslan et al	2020	No	No	Yes	No
6	Gabriel et al	2021	Yes	Yes	Yes	Yes

Figure 1. Demonstrating the search flowchart.

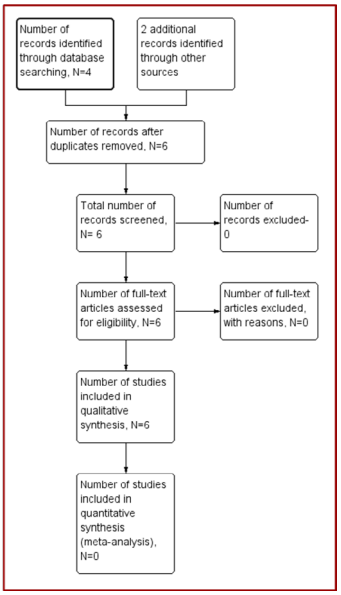


Figure 2. Demonstrating Risk of bias summary.

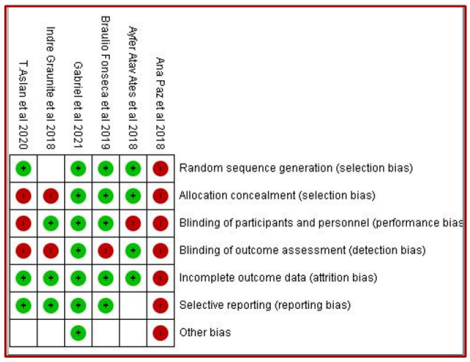
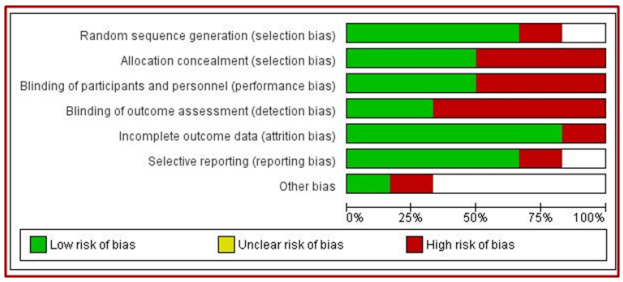


Figure 3. DemonstratingRisk of bias graph.



Quality Assessment

(Higgins and Green. Cochrane reviewer's Handbook 2009)
The quality assessment of included trials was undertaken independently as a part of the data extraction process. Four main criteria were examined.

1. Method of randomization

a. Yes- Adequate as described in the text
b. No- Inadequate as described in the text
c. Unclear in the text

2. Allocation Concealment

a. Yes- Adequate as described in the text
b. No- Inadequate as described in the text
c. Unclear in the text

3. Outcome assessors blinded to intervention

a. Yes- Adequate as described in the text
b. No- Inadequate as described in the text
c. Unclear in the text

4. Completeness of follow up

a. Yes- Adequate as described in the text
b. No- Inadequate as described in the text
c. Unclear in the text

The purpose of this review is to assess the intensity of postoperative pain after using bioceramic sealers and resin based sealers. Six clinical studies fulfilled the criteria for being included in this review. (Indre Graunite et al, 2018; Ana Paz et al, 2018; Ayfer Atav Ates et al, 2018; Braulio Fonseca et al, 2019; T. Aslan et al, 2020; Gabriel et al, 2021).

Interpretation of the results

From the six included studies, a total of 815 teeth (from 573 patients) were included. The gender distribution was 150 males and 213 females with different age groups.

In the study conducted by Indre Graunite et al, out of 61 patients only premolars and anterior teeth were included. Based on the results, it was observed that lower premolars had a significantly higher pain compared with the anterior teeth. Postoperative pain was measured at 4 time points: 24 hours, 48 hours, 72 hours, and 7 days. In this trial, there was no statistically significant difference in the pain occurrence between root canals obturated with different sealers observed at any of the assessed time points. In this study, it was concluded that the sealers performed similarly in terms of occurrence and intensity of postoperative pain.

In the study conducted by Braulio Fonseca et al, 64 patients requiring endodontic treatment of single-rooted maxillary teeth with necrotic pulps were included. The treatments of necrotic teeth were performed in a single visit with the same single-file reciprocating protocol. The canals were irrigated, dried and were randomly divided into two different groups depending on the type of sealer used: resin-based group (RG) in which the canals were filled with the AH Plus, and the bioceramic group (BG) in which the canals were filled with the Sealer Plus BC. The pain score was recorded on VAS at 24-hour, 48-hour, 72-hour, and 1-week intervals. The results showed that sealer extrusion occurred in nine patients of the RG and in 19 patients of the BG which highlights that sealer extrusion was significantly more in BG group compared to RG group. But the sealer extrusion was not associated with pain. This study concluded that the average pain levels were similar in both groups.

In a study conducted by Aslan et al, a total of 90 patients having one first or second molar tooth diagnosed with asymptomatic irreversible pulpitis were randomly divided into three groups

according to the sealer used. The patients included in the study underwent single visit root canal treatment. The pain score was recorded on VAS 6, 12, 24 and 48 h, and 3, 4, 5, 6 and 7 days. The results showed that there were no significant differences amongst the groups in terms of postoperative pain at any time points assessed. The study concluded that the sealers tested were associated with similar levels of postoperative pain.

Ana Paz et al conducted a study wherein he evaluated the postoperative pain after using a bioceramic material as an endodontic sealer with single cone technique, and compared the 1results with a resin based endodontic sealer with the cold lateral condensation technique and the continuous wave of condensation. A total of 30 patients were divided randomly for each group of obturation systems. The pain score was recorded on VAS for 7 days post treatment. The results showed that Single cone + Bioceramic referred post-operative pain more frequently than Continuous wave + resin sealer or Lateral condensation + resin sealer. The results also showed that the bioceramic group presented the highest intensity of moderate pain intensity during the 7 day evaluation period. The study concluded that more number of studies are required with larger sample sizes.

Ayfer Atav et al conducted a study wherein 160 patients with vital and non vital teeth. They were randomized into four groups using a randomized block design with block sizes of 10 patients each with two types of sealers AH plus and Bioceramic sealers. Postoperative pain was recorded by visual analogue scale at 6, 12, 24, and 72 h after obturation. The results showed that there was no significant difference between groups in the incidence of postoperative pain.

Gabriel et al conducted a study wherein 168 patients with non vital teeth. At the time of obturation, teeth were randomly assigned to use AH plus or TotalFill BC sealer using random permuted block design. Postoperative pain was recorded using a 5 point Likert scale over a period of seven days. The results showed that there was no significant difference between the two sealers in terms of pain experienced.

Summary

Of the six included studies, it is seen that there is no significant difference in the incidence of postoperative pain after using bioceramic and resin based sealers except in a study conducted by Ana Paz et al wherein it was shown that usage of bioceramic sealer was associated with increased postoperative pain compared to Resin sealer. However the quality of the clinical trial was low having a high risk of bias. In one of the studies, it was found that there was no correlation between sealer extrusion and the occurrence of postoperative pain. [12] On the other hand, one of the studies highlighted that there were no significant differences among the groups in terms of postoperative pain at any time points assessed nor for analgesic intake of patients among the groups.[34] The other study inferred that bioceramic sealer caused more extrusion compared to resin sealer. But it was seen that sealer extrusion was not associated with postoperative pain. [35]

Whereas in one of the studies conducted by Ana Paz et al, he studied the combined effect of obturation technique and the type of sealer that influences the postoperative pain. In this study, it was found that the highest intensity of postoperative pain was presented by single cone and bioceramic sealer compared to continuous wave and resin sealer. However the sample size was limited to make a conclusive study and the mechanism by which the technique of obturation influenced the postoperative pain was not explained clearly. [36]

In another study conducted by Ayfer Atal et al, results showed that there was no significant difference between groups in the incidence of postoperative pain; however, iRoot SP sealer (bioceramic sealer) was associated with less analgesic intake compared to AH Plus sealer (resin sealer).[37] In another study conducted by Gabriel et al, results showed that there was no significant difference in the pain experienced between the two groups(AH plus sealer and Total Fill BC sealer). [38]

Our institution is passionate about high quality evidence based research and has excelled in various fields [23, 39-48].

Implications for Practice

Bioceramic or resin based sealers should be chosen to aim at reducing the postoperative pain.

Implications for Research

In future, research should be aimed at utilizing a sealer to reduce the postoperative pain.

Conclusion

With the available evidence from the included studies, the quality of the clinical trials was moderate. Most of the included studies did follow a common methodology to assess the incidence of postoperative pain. The results of five included studies concluded that there was no significant difference in the pain level when the different sealers were used. More number of clinical trials adhering to the correct method of randomisation, allocation concealment and blinding have to be carried out to arrive at a definitive conclusion regarding the occurrence of postoperative pain following the usage of resin based and bioceramic sealers in endodontically treated teeth.

Acknowledgements

We would like to acknowledge the department of Conservative dentistry and Endodontics for helping us to access the required data.

References

[1]. Rajendran R, Kunjusankaran RN, Sandhya R, Anilkumar A, Santhosh R, Patil SR. Comparative evaluation of remineralizing potential of a paste containing bioactive glass and a topical cream containing casein phosphopeptide-amorphous calcium phosphate: An in vitro study. Pesqui Bras Odontopediatria Clin Integr. 2019 Oct 10;19.
[2]. Mahalakshmi Nandakumar IN. Comparative evaluation of grape seed and cranberry extracts in preventing enamel erosion: An optical emission spectrometric analysis. J Conserv Dent. 2018 Sep;21(5):516-20.
[3]. Rajakeerthi R, Nivedhitha MS. Natural Product as the Storage medium for an avulsed tooth–A Systematic Review. Cumhur. Dent. J. 2019 Jun 11;22(2):249-56.
[4]. Manohar MP, Sharma S. A survey of the knowledge, attitude, and aware-

ness about the principal choice of intracanal medicaments among the general dental practitioners and nonendodontic specialists. Indian J Dent Res. 2018 Nov-Dec;29(6):716-720.Pubmed PMID: 30588997.

[5]. Siddique R, Sureshbabu NM, Somasundaram J, Jacob B, Selvam D. Qualitative and quantitative analysis of precipitate formation following interaction of chlorhexidine with sodium hypochlorite, neem, and tulsi. J Conserv Dent. 2019 Jan-Feb;22(1):40-47.Pubmed PMID: 30820081.

[6]. Teja KV, Ramesh S, Priya V. Regulation of matrix metalloproteinase-3 gene expression in inflammation: A molecular study. J Conserv Dent. 2018 Nov;21(6):592-6.

[7]. Azeem RA, Sureshbabu NM. Clinical performance of direct versus indirect composite restorations in posterior teeth: A systematic review. J. Conserv. Dent. 2018 Jan;21(1):2-9.

[8]. Malli Sureshbabu N, Selvarasu K, V JK, Nandakumar M, Selvam D. Concentrated Growth Factors as an Ingenious Biomaterial in Regeneration of Bony Defects after Periapical Surgery: A Report of Two Cases. Case Rep Dent. 2019 Jan 22;2019:7046203.Pubmed PMID: 30805222.

[9]. Janani K, Sandhya R. A survey on skills for cone beam computed tomography interpretation among endodontists for endodontic treatment procedure. Indian J Dent Res. 2019 Nov-Dec;30(6):834-838.Pubmed PMID: 31939356.

[10]. Sathorn C, Parashos P, Messer H. The prevalence of postoperative pain and flare-up in single- and multiple-visit endodontic treatment: a systematic review.Int. Endod. J. 2007: 071025011828001.

[11]. Govindaraju L, Neelakantan P, Gutmann JL. Effect of root canal irrigating solutions on the compressive strength of tricalcium silicate cements. Clin Oral Investig. 2017 Mar;21(2):567-571.Pubmed PMID: 27469101.

[12]. Graunaite I, Skucaite N, Lodiene G, Agentiene I, Machiulskiene V. Effect of Resin-based and Bioceramic Root Canal Sealers on Postoperative Pain: A Split-mouth Randomized Controlled Trial. J Endod. 2018 May;44(5):689-693.Pubmed PMID: 29571915.

[13]. Ramarao S, Sathyanarayanan U. CRA Grid - A preliminary development and calibration of a paper-based objectivization of caries risk assessment in undergraduate dental education. J Conserv Dent. 2019 Mar-Apr;22(2):185-190. Pubmed PMID: 31142991.

[14]. Zhang W, Peng B. Tissue reactions after subcutaneous and intraosseous implantation of iRoot SP, MTA and AH Plus. Dent Mater J. 2015;34(6):774-80.Pubmed PMID: 26632225.

[15]. Khandelwal A, Palanivelu A. Correlation between dental caries and salivary albumin in adult population in Chennai: An in vivo study. Braz. Dent. Sci. 2019 Apr 30;22(2):228-33.

[16]. Koch K, Brave D. The increased use of bioceramics in endodontics. Dentaltown. 2009 Apr;10:39-43.

[17]. Cherng AM, Chow LC, Takagi S. In vitro evaluation of a calcium phosphate cement root canal filler/sealer. J. Endod. 2001 Oct 1;27(10):613-5.

[18]. Langeland K, Block RM, Grossman LI. A histopathologic and histobacteriologic study of 35 periapical endodontic surgical specimens. J Endod. 1977 Jan;3(1):8-23.Pubmed PMID: 264931.

[19]. Govindaraju L, Gurunathan D. Effectiveness of Chewable Tooth Brush in Children-A Prospective Clinical Study. J Clin Diagn Res. 2017 Mar;11(3):ZC31-ZC34.Pubmed PMID: 28511505.

[20]. Christabel A, Anantanarayanan P, Subash P, Soh CL, Ramanathan M, Muthusekhar MR, et al. Comparison of pterygomaxillary dysjunction with tuberosity separation in isolated Le Fort I osteotomies: a prospective, multi-centre, triple-blind, randomized controlled trial. Int J Oral Maxillofac Surg. 2016 Feb;45(2):180-5.Pubmed PMID: 26338075.

[21]. Soh CL, Narayanan V. Quality of life assessment in patients with dentofacial deformity undergoing orthognathic surgery--a systematic review. Int J Oral Maxillofac Surg. 2013 Aug;42(8):974-80.Pubmed PMID: 23702370.

[22]. Mehta M, Deeksha, Tewari D, Gupta G, Awasthi R, Singh H, et al. Oligonucleotide therapy: An emerging focus area for drug delivery in chronic inflammatory respiratory diseases. Chem Biol Interact. 2019 Aug 1;308:206-215.Pubmed PMID: 31136735.

[23]. 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):115-121.Pubmed PMID: 30451321.

[24]. Campeau PM, Kasperaviciute D, Lu JT, Burrage LC, Kim C, Hori M, et al. The genetic basis of DOORS syndrome: an exome-sequencing study. Lancet Neurol. 2014 Jan;13(1):44-58.Pubmed PMID: 24291220.

[25]. Sneha S. Knowledge and awareness regarding antibiotic prophylaxis for infective endocarditis among undergraduate dental students. Asian J Pharm Clin Res. 2016 Oct 1:154-9.

[26]. Christabel SL, Linda Christabel S. Prevalence of type of frenal attachment and morphology of frenum in children, Chennai, Tamil Nadu. World J. Dent. 2015 Oct;6(4):203-7.

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

[28]. Sridharan G, Ramani P, Patankar S. Serum metabolomics in oral leukoplakia and oral squamous cell carcinoma. J Cancer Res Ther. 2017 Jul 1;13(3):556-61.

[29]. Ramesh A, Varghese SS, Doraiswamy JN, Malaiappan S. Herbs as an antioxidant arsenal for periodontal diseases. J Intercult Ethnopharmacol. 2016 Jan 27;5(1):92-6.Pubmed PMID: 27069730.

[30]. Thamaraiselvan M, Elavarasu S, Thangakumaran S, Gadagi JS, Arthie T. Comparative clinical evaluation of coronally advanced flap with or without platelet rich fibrin membrane in the treatment of isolated gingival recession. J Indian Soc Periodontol. 2015 Jan;19(1):66-71.

[31]. Thangaraj SV, Shyamsundar V, Krishnamurthy A, Ramani P, Ganesan K, Muthuswami M, et al. Molecular Portrait of Oral Tongue Squamous Cell Carcinoma Shown by Integrative Meta-Analysis of Expression Profiles with Validations. PLoS One. 2016 Jun 9;11(6):e0156582.Pubmed PMID: 27280700.

[32]. Ponnulakshmi R, Shyamaladevi B, Vijayalakshmi P, Selvaraj J. In silico and in vivo analysis to identify the antidiabetic activity of beta sitosterol in adipose tissue of high fat diet and sucrose induced type-2 diabetic experimental rats. Toxicol Mech Methods. 2019 May;29(4):276-290.Pubmed PMID: 30461321.

[33]. Ramakrishnan M, Shukri M. Fluoride, Fluoridated Toothpaste Efficacy And Its Safety In Children-Review. Int. J. Pharm. Sci. Res.2018 Oct 1;10(04):109-14.

[34]. Aslan T, Dönmez Özkan H. The effect of two calcium silicate-based and one epoxy resin-based root canal sealer on postoperative pain: a randomized controlled trial. Int Endod J. 2020.

[35]. Fonseca B, Coelho MS, da Silveira Bueno CE, Fontana CE, De Martin AS, Rocha DG. Assessment of extrusion and postoperative pain of a bioceramic and resin-based root canal sealer. Eur J Dent. 2019 Jul;13(03):343-8.

[36]. Paz ABG. Evaluation of postoperative pain after using bioceramic materials as endodontic sealers: randomized control clinical trial. 2017.

[37]. Ates AA, Dumani A, Yoldas O, Unal I. Post-obturation pain following the use of carrier-based system with AH Plus or iRoot SP sealers: a randomized controlled clinical trial. Clin Oral Investig. 2019 Jul;23(7):3053-61.

[38]. TH SG, Chong LK, Nee LJ, LW MC, VS HY. Post-obturation pain associated with tricalcium silicate and resin-based sealer techniques-a randomized clinical trial. J. Endod. 2020 Oct 21.

[39]. 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):1441-1448.Pubmed PMID: 31257588.

[40]. Pc J, Marimuthu T, Devadoss P, Kumar SM. Prevalence and measurement of anterior loop of the mandibular canal using CBCT: A cross sectional study. Clin Implant Dent Relat Res. 2018 Apr 6;20(4):531-4.

[41]. 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):1241-1248.Pubmed PMID: 30044495.

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

[43]. 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.

[44]. 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 Sep;24(9):1-6.Pubmed PMID: 31955271.

[45]. 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):285-286.Pubmed PMID: 32416620.

[46]. R H, Ramani P, Ramanathan A, R JM, S G, Ramasubramanian A, et al. CYP2 C9 polymorphism among patients with oral squamous cell carcinoma and its role in altering the metabolism of benzo[a]pyrene. Oral Surg Oral Med Oral Pathol Oral Radiol. 2020 Sep;130(3):306-312.Pubmed PMID: 32773350.

[47]. 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.Pubmed PMID: 33043408.

[48]. 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;94:93-98.Pubmed PMID: 30015217.