

A Comparative Study Of Knowledge and Protocols Followed For Application Of Dentin Bonding Agents Amongst General Dental Practitioners and Endodontists In Chennai: A Questionnaire Based Survey

Research Article

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Abstract

Introduction: Bonding plays an integral role in adhesion of the resin restoration to the tooth structure. Bonding to the dentin possesses a greater challenge than bonding to the enamel. Following the correct protocol based of scientific evidence is hence highly imperative for the longevity of the restoration. The present study was conducted with the aim to compare and assess the protocols followed for application of dentin bonding agent amongst general dentists and Endodontists in Chennai.

Materials and Method: The present cross-sectional survey was carried out amongst a total of 384 dental practitioners with an equal representation of general dentist and Endodontists in Chennai. Data was collected using a self-designed questionnaire and was assessed using descriptive statistical analysis and chi square test.

Results: The study showed that 52.6% practitioners used rubber dam isolation only some times. Prior to restoration, 49.2% practitioners preferred complete removal of the smear layer. Etch and rinse total etch technique was the protocol followed by majority of the practitioners. Majority of the practitioners applied one or two layers of bonding agent and cured it for 20 seconds. There was lack of awareness regarding the intensity of the curing light amongst 33.6% practitioners. A majority of 94.3% practitioners felt the need for knowledge upgradation.

Conclusion: The study concluded that while some dental practitioners aptly follow the bonding protocols, there is still the need to upgrade knowledge regarding the more recent adhesives and their bonding protocols.

Keywords: Dental Adhesives; Bonding Agents; Self Etch Adhesives; Dental Acid Etching; Smear Layer; Dentin.

Introduction

Before the advent of composites, silver amalgam was the choice of restorative material for posterior teeth; owing to its high compressive strength. [1] Recently, the demand for aesthetic restorations has increased, leading to increased use of composite resins for posterior restorations. [2] Although highly aesthetic, composite restorations are highly technique sensitive. [3]

Composite resins bond micromechanically to the tooth structure. [4] Bonding to dentin possesses a greater challenge, unlike bond-

ing to enamel. [5] The bonding protocols have evolved from the conventional etch and rinse technique, to the more recent selective etch technique and self etch adhesives. Self etch adhesives have the benefit of the absence on intermediary step of rinsing, which makes it more user friendly and less technique sensitive while bonding dentin to the resin restoration. [6] Self etch adhesives do not open the dentinal tubules, rather they dissolve the smear plug. [7] On the other hand, enamel benefits from the etch and rinse technique, owing to its ability to create micro porosities. [8] This concept lead to the evolution of selective etch technique where enamel is selectively etched prior to application of a uni-

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versal adhesive.

Having the right knowledge and understanding of the properties of various adhesive systems will help the dental practitioner adopt the technique best suited for enamel and dentine respectively. Only when the correct protocols are followed, will the restoration have a successful outcome. Composite restorations are performed by general dental practitioners as well as Endodontists who even specialize in the field of conservative and restorative dentistry.

Previously our team had conducted numerous clinical studies [9, 12], case reports [13], in vitro studies [14, 17], surveys [18, 19] and reviews [20, 23] in various aspects of endodontics and conservative dentistry over the past five years from which the idea of the present study has stemmed. Thus the present survey was conducted to compare the bonding protocols followed by the general dental practitioners and Endodontists.

Aim and Objectives

The present study was conducted with an aim to study and compare the attitude and explore the materials and techniques employed during application of dentin bonding agents by general dentists and Endodontists in Chennai and determine ways to reinforce their knowledge and skills for delivering a more proficient treatment.

The study was carried out with the underlying objectives:

To study and compare the attitude of general dentists and Endodontists towards the application of dentin bonding agents.

To explore and compare the materials and techniques employed by the general dentists and Endodontists during application of dentin bonding agents.

To come to a conclusion as to how the general dentists and Endodontists can upgrade themselves for provision of a more efficient treatment.

Materials and Methods

The present cross sectional questionnaire based survey was conducted amongst 384 general dentists and Endodontists in Chennai who were selected through block randomization. Lottery Method was adopted for selection of practitioners from each block to ensure a random sampling & equal representation from each area. The inclusion criterion was set to include the general dentists and those associated with the specialty of Endodontics (students currently enrolled in the Endodontic post graduate program and the practicing Endodontists) willing to participate in the present survey and giving a written informed consent. The exclusion criteria of the study included those practitioners who were absent on the day of the survey and up to two rounds of follow up. Single proportion formula was used to determine a sample size of minimum 384 dental practitioners as follows:

$$N = (Z\alpha p (1-p)/d)^2$$

N = sample size estimated.

Z α = variant of type one error.

p = proportion of good practice of dentin bonding technique assumed at 50%

d = estimated error in the present study fixed at 5%.

Hence a minimum of 384 dental practitioners were included in the study. Using a cluster design, there were two groups for comparison. Hence a minimum of 192 subjects were present in each group.

Prior to the start of the study, clearance and permissions were obtained from Institutional ethics committee (IEC) after the study protocol was sent and reviewed by 2 blinded reviewers.

Data was collected using a self designed, pre tested questionnaire comprising of 18 questions which was circulated amongst the general dentists and Endodontists. The questionnaire comprised of 5 sections. Section A comprised of questions on demographic details. Section B comprised of questions regarding isolation and bonding techniques used in different depths of cavities. Section C comprised of questions on etching protocols. Section D comprised of question on bonding protocols. Section E comprised of questions regarding the need for knowledge upgradation.

The questionnaire was collected on completion by the primary investigator. M.S Office excel sheet (V.2010) was used to code and enter the collected data. Descriptive statistics in the form of frequency and percentage were calculated using Statistical Package for Social Sciences (SPSS, V.22.0, 1BM). Comparison of frequencies of categories of variables with groups was done using chi square test. For all the statistical tests, $p < 0.05$ was considered to be statistically significant, keeping α error at 5% and β error at 20%, thus giving a power to the study as 80%.

Results and Discussion

In the present study 192 general dentists and 192 Endodontists were included. Amongst the participants 61.2% were female and 38.8% were male practitioners. The practitioners were further divided into two groups based on their years of experience. Group A comprised of 330 dental practitioners who had an experience of less than 10 years and group B comprised of 54 dental practitioners who had an experience of 10 years or more.

It was observed that 52.6% practitioners used a rubber dam only sometimes while placing a composite restoration, of which 114 were Endodontists and 88 were general dentists. An alarming number of 59 general dentists said they never used a rubber dam as compared to only 3 Endodontists. Yet, a majority of 65.4% practitioners said they felt that complete isolation using rubber dam was always necessary. General dentists mainly preferred complete removal of smear layer prior to bonding while modification of the dentinal smear layer was preferred by Endodontists. (Graph 1).

The general dentists and Endodontists followed a similar protocol of 'etch and rinse' total etch technique for etching the enamel. While a majority of 93 general dentists preferred the etch and rinse total etch technique for cavities involving the dentin; selective etch technique was preferred by the Endodontists. Both the general dentists and Endodontists preferred Indirect Pulp Capping (IPC) followed by base for deep cavities and used the etch

and rinse total etch technique while only 22.75% practitioners adopted the selective etch protocol. (Graph 2)

Calcium hydroxide was the choice of indirect pulp capping agent by 127 general dentists, while 83 Endodontists preferred Biodentin. Glass ionomer cement (GIC) was the choice for base by 50.8% practitioners of which majority were general dentists, while Biodentin was preferred by Endodontists. (Graph 3)

A majority of 53.6% practitioners preferred etching for 15 seconds, while etching for 20 seconds was mainly preferred by the general dentists. A majority of 44.5% practitioners rinsed the cavity for 10 seconds post etching. For drying the cavity, 104 general dentists used air through a three way syringe to dry the entire cavity while 70 Endodontists used an absorbent paper selectively for the dentin and used air to dry the enamel only. (Graph 4)

A majority of 91 general dentists preferred applying a single layer of bonding agent while a majority of 88 Endodontists applied two layers of bonding agent. When asked if they used air to spread the bonding agent, a majority of 39.1% practitioners with an equal distribution of Endodontists and general dentists said they always did. While 70 general dentists said they never did, 68 Endodontists said they used air to spread the bonding agent only sometimes. (Graph 5)

A majority of 44% practitioners including the general dentists and Endodontists cured the bonding agent for 30 seconds. When asked about the intensity of the curing light, a majority of 86 general dentists were not aware of it while majority of Endodontists used curing light of intensity between 300 to 1300mW/cm². A majority of 88.8% practitioners held the curing light directly over the tooth, but not touching the tooth. (Graph 6)

A majority of 94.3% practitioners felt the need to upgrade their knowledge and 76% practitioners felt that workshops, seminars and symposiums were efficient ways of knowledge upgradation. (Graph 7)

Statistical significant difference in responses was observed while comparing the two groups based on type of practice and years of experience (P<0.05). (Table 1 and 2)

The present study revealed that the more recent techniques of modification of dentinal smear layer and the use of selective etch technique were mainly preferred by the Endodontists. They also preferred the use of biodentin against the conventional calcium hydroxide for IPC. One of the probable reasons for this could be that the Endodontists get trained in the field of conservative

dentistry during their post graduation, giving them an opportunity to learn the more recent advances at the institutional level.

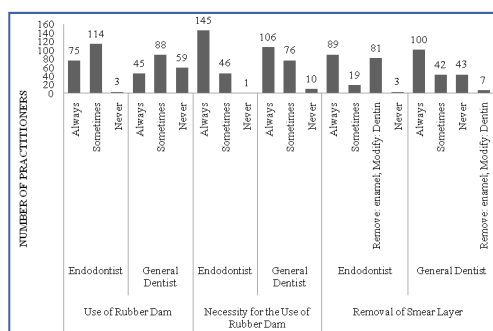
In the present study, it was seen that complete isolation using rubber dam is not always performed during a composite restoration even though the practitioners were aware of its importance. These results are in accordance to a study conducted by Gilmour. et.al which states that only 5% of the general dental practitioners in UK placed rubber dam during posterior composite restoration. [24] The role of rubber dam in maintaining a sterile environment at the site of the procedure cannot be deemphasized. Moreover, the bonding of a composite restoration to the tooth structure requires an environment that is free of moisture contamination. [25]

Complete removal of smear layer using the etch and rinse total etch technique was still the most prevalent etching protocol irrespective of the depth of the cavity. An etching time of 15 seconds followed by rinsing for 10 seconds and drying the cavity using air through a three way syringe was the protocol that was opted by a majority of the practitioners. These results are in accordance to a study conducted by Nesser.et.al amongst senior dental students. [6]

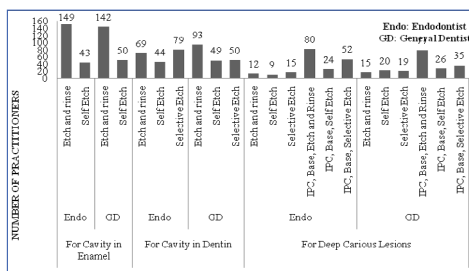
Currently there are two approaches for bonding which are widely being followed; ‘etch and rinse’ and the ‘self-etch’ technique. During cavity preparation, a smear layer is formed on the tooth surface which prevents effective bonding of the restoration. [26] The ‘etch and rinse total etch’ approach focuses on complete removal of this smear layer. [27] However, complete removal of smear layer from the dentin opens the dentinal tubules and increases the permeability through the tubules. [28] This dentinal fluid is believed to affect the bond strength. [29] The self etch adhesives focus on incorporating the smear layer. [30] The effect of acid etching on enamel and dentin differ due to their different compositions. Acid etching is beneficial for enamel owing to its ability to dissolve enamel rods and create micro porosities. [31] However, Dentin contains dentinal fluids and only 70% inorganic matter. Acid etching of dentin exposes the collagen fibrils which are then completely uncovered by hydroxyapatite crystals. [7, 27]

The ‘etch and rinse’ approach, requires the acid to be rinsed, followed by drying of the cavity as an intermediary step. Excessive drying of the cavity results in dehydration of dentin which eventually leads to collapse of the collagen fibrils. Once the collagen fibrils collapse, it prevents the diffusion of the resin monomer. Hence dentin requires some amount of water to keep the collagen fibrils intact to facilitate the formation of hybrid layer. [32] However, presence of excessive moisture prevents the complete

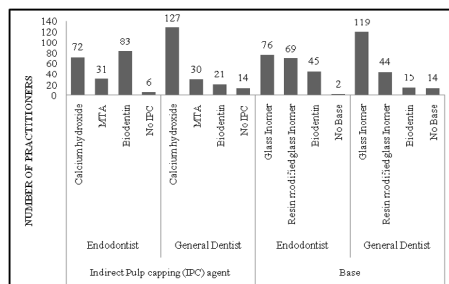
Graph 1: Protocol for Isolation and Removal of Smear Layer



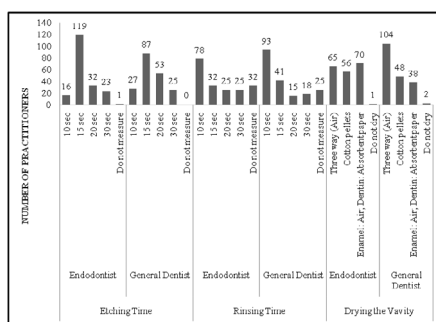
Graph 2: Protocol for Etching of Cavities of Various Depths



Graph 3: Protocol for Indirect Pulp Capping (IPC) Agent and Base



Graph 4: Protocol for Etching



polymerization of resin and leads to adsorption of water in the hybrid layer. [33] Thus the ‘etch and rise’ approach is highly technique sensitive when used in prepared cavities that involve dentin. One of the approaches to prevent dehydration of dentin is to use an absorbent paper selectively for drying the dentinal tissue and using air to dry enamel only.

As ‘Self-etch’ adhesives simplify the control of moisture they are best suited for dentin. However, the ‘etch and rinse’ approach is highly imperative to achieve adequate bond strength between the enamel and resin restoration. [34] The selective etch technique focuses on etching the enamel to improve the bond strength before the application of a universal adhesive.

Frankenberger.et.al in his study to compare the ‘etch and rinse’, ‘self-etch’ and ‘selective etch’ approach, states that bonding of the resin restoration to enamel when a self etch adhesive is used, is more effective when enamel is etched using phosphoric acid. [35] These results were in accordance to the study conducted by Ermis.at.al. [36]

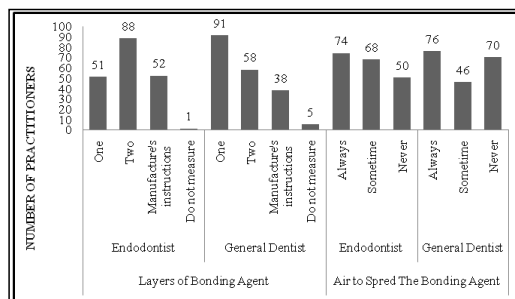
The difference in the inorganic and organic composition of enamel and dentine also has an effect on the etching time. It is desirable to dissolve only minimum amount of enamel and dentin that is adequate enough to give optimum bond strength [37]. While enamel requires an etching time of 30 seconds, an etching time of 15 seconds is adequate for dentin [38]. Etching increases the concentration of calcium and phosphate ions at the gel-tooth

interphase. This results in precipitate formation. Rinsing post etching is mandatory to eliminate the etchant and the precipitate. [39]. The benefit of rinsing the cavity for duration that is comparable to the etching time as been proven in literature. It aids in adequate dissolution of minerals and prevents the formation of white halos around the margins of the prepared cavity [6].

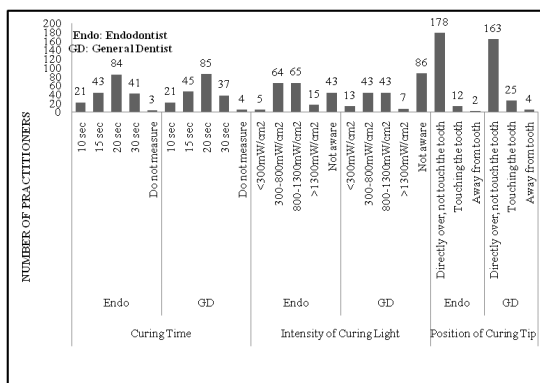
In the present study it was observed that even though the practitioners were aware of the need for complete polymerization of the bonding agent, a majority lacked the awareness of the intensity of curing light being used.

To compensate for the polymerization stress, it has been proven advisable to apply more than one layer of bonding agent. [40, 41] Using air to spread the adhesive prevents its pooling within the cavity. [42] The curing efficiency of the bonding agent is best when the curing tip is placed close to the tooth. The further the tip is placed, more are the chances of incomplete polymerization. [43] However, touching of the curing tip to the tooth being restored might lead to cross contamination. [44] An adequate curing time and intensity of the curing light is essential for complete curing of the bonding agent. It has been observed in previous studies that most of the practitioners cure the bonding agent for a minimum time of 20 seconds while keeping the curing tip close to the tooth being restored but not touching it. [6] Further, an intensity of more than 800 mW/cm² ensures optimum polymerization. [45]

Graph 5: Protocol for Application of Bonding Agent



Graph 6: Protocol for Curing the Bonding Agent



Graph 7: Need for Knowledge Upgradation

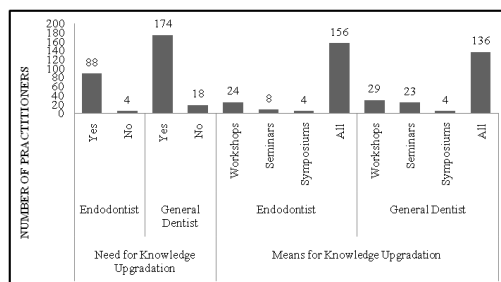


Table 1: Statistically Significant Responses While Comparing General Dental Practitioners and Endodontists (P<0.01, <0.05).

Questions	Responses	Endodontist	General Dentist	P Value of Chi Square Test
Use of rubber dam for isolation A: Always B: Sometimes C: Never	A B C	75 114 3	45 88 59	0.000**
Necessity for the use of rubber dam for complete isolation A: Always B: Sometimes C: Never	A B C	145 46 1	106 76 10	0.000**
Necessity to remove smear layer for dentin bonding A: Always B: Sometimes C: Remove completely from enamel and modify for dentin D: Never	A B C D	89 19 81 3	100 42 43 7	0.000**
Choice of etching technique for cavity that extends into the dentin A: etch and rinse total etch B: Self etch C: Selective etch	A B C	69 44 79	93 49 50	0.006**

Choice of indirect pulp capping agent under a composite restoration A: Calcium Hydroxide B: MTA C: Biodentin D: I do not perform indirect pulp capping	A B C D	72 31 83 6	127 30 21 14	0.000**
Choice of base under a composite restoration A: Glass Inomer Cement B: Resin Modified Glass Inomer Cement C: Biodentin D: I do not use a base	A B C D	76 69 45 2	119 44 15 14	0.000**
Etching time A: 10 seconds B: 15 seconds C: 20 seconds D: 30 seconds E: I do not measure the time	A B C D E	16 119 32 23 1	27 87 53 25 0	0.007**
Drying the cavity post rinsing A: Air through a three way syringe B: Cotton pellets C: Absorbent paper selectively for dentin and air for enamel D: I do not dry the cavity	A B C D	65 56 70 1	104 48 38 2	0.000**
Number of layers of bonding agent A: One B: Two C: Manufacturer's instructions D: I do not measure	A B C D	51 88 52 1	91 58 38 5	0.000**
Use of air to spread the bonding agent A: Always B: Sometimes C: Never	A B C	74 68 50	76 46 70	0.022*
Intensity of curing light used A: < 300mW/cm ² B: 300 to 800mW/cm ² C: 800 to 1300mW/cm ² D: > 1300mW/cm ² E: I am not aware	A B C D E	5 64 65 15 43	13 43 43 7 86	0.000**

Table 2: Statistically Significant Responses While Comparing the Two Groups Based on Years of Experience (P<0.01, <0.05).

Questions	Responses	Group A: 1-9 yrs	Group B: >10 yrs	P Value of Chi Square Test
Use of rubber dam for isolation A: Always B: Sometimes C: Never	A B C	111 171 48	9 31 14	0.016*
Necessity for the use of rubber dam for complete isolation A: Always B: Sometimes C: Never	A B C	225 96 9	26 26 2	0.016*
Choice of etching technique for cavity that extends into the dentin A: etch and rinse total etch B: Self etch C: Selective etch	A B C	143 84 103	19 9 26	0.046*
Choice of etching technique for cavity deep cavities A: Etch and rinse total etch B: Self etch C: Selective etch D: IPC, Base, etch and rinse total etch E: IPC, Base and self etch F: IPC, Base and selective etch	A B C D E F	25 25 24 145 42 69	2 4 10 12 8 18	0.006**
Choice of indirect pulp capping agent under a composite restoration A: Calcium Hydroxide B: MTA C: Biodentin D: I do not perform indirect pulp capping	A B C D	182 48 85 15	17 13 19 5	0.011*

Choice of base under a composite restoration A: Glass Inomer Cement B: Resin Modified Glass Inomer Cement C: Biodentin D: I do not use a base	A B C D	180 97 43 10	15 16 17 6	0.000**
Duration of rinsing post etching A: 10 seconds B: 15 seconds C: 20 seconds D: 30 seconds E: I do not measure	A B C D E	156 63 34 34 43	15 10 6 9 14	0.028*
Drying the cavity post rinsing A: Air through a three way syringe B: Cotton pellets C: Absorbent paper selectively for dentin and air for enamel D: I do not dry the cavity	A B C D	148 95 84 3	21 9 24 0	0.025*
Number of layers of bonding agent A: One B: Two C: Manufacturer's instructions D: I do not measure	A B C D	132 125 68 5	10 21 22 1	0.003**
Use of air to spread the bonding agent A: Always B: Sometimes C: Never	A B C	115 103 112	35 11 8	0.000**
Intensity of curing light used A: < 300mW/cm2 B: 300 to 800mW/cm2 C: 800 to 1300mW/cm2 D: > 1300mW/cm2 E: I am not aware	A B C D E	18 93 84 20 115	0 14 24 2 14	0.032*

One possible limitation of the present study is that the data collected is from a single geographical area. Considering the source of information, the participants gather to update their knowledge and skills. Hence we assume the extrapolation of the results of the present study to be generalized to all general dentists and Endodontists across India.

Conclusion

The present survey reflects that even though some practitioners follow the protocols for dent in bonding aptly, the need for knowledge upgradation remains. Newer adhesives and techniques have evolved based on scientific reasoning to improve the bond strength. The Endodontists are more acquainted with these owing to their expertise in the specialty of conservative dentistry. It is only through continuing education that the practitioners can update themselves with the recent advances so as practice evidence based dentistry.

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References

- [1]. Peyton FA, Liatukas EL. Compressive strength of amalgam as influenced by different condensation forces. *J Prosthet Dent.* 1961 Sep 1;11(5):934-41.
- [2]. Demarco FF, Corrêa MB, Cenci MS, Moraes RR, Opdam NJ. Longevity of posterior composite restorations: not only a matter of materials. *Dent Mater.* 2012 Jan 1;28(1):87-101.
- [3]. Sarrett DC. Clinical challenges and the relevance of materials testing for posterior composite restorations. *Dent Mater.* 2005 Jan;21(1):9-20.Pubmed PMID: 15680997.

- [4]. Buonocore MG, Matsui A, Gwinnett AJ. Penetration of resin dental materials into enamel surfaces with reference to bonding. *Arch Oral Biol.* 1968 Jan;13(1):61-70.Pubmed PMID: 5237555.
- [5]. Kumar JS, Jayalakshmi S. Bond failure and its prevention in composite restoration-a review. *J. Pharm. Sci. Res.* 2016 Jul 1;8(7):627.
- [6]. Nassar H, El-Shamy H. Bonding System Choice and Practices among Senior Dental Students. *J Int Soc Prev Community Dent.* 2017 Nov;7(Suppl 3):S143-S148.Pubmed PMID: 29285469.
- [7]. Van Landuyt K, De Munck J, Coutinho E, Peumans M, Lambrechts P, Van Meerbeek B. Bonding to dentin: smear layer and the process of hybridization. *InDental hard tissues and bonding 2005* (pp. 89-122). Springer, Berlin, Heidelberg.
- [8]. BUONOCORE MG. A simple method of increasing the adhesion of acrylic filling materials to enamel surfaces. *J Dent Res.* 1955 Dec;34(6):849-53. Pubmed PMID: 13271655.
- [9]. 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;19:4668.
- [10]. Jenarathan S, Subbarao C. Comparative evaluation of the efficacy of diclofenac sodium administered using different delivery routes in the management of endodontic pain: A randomized controlled clinical trial. *J Conserv Dent.* 2018 May-Jun;21(3):297-301.Pubmed PMID: 29899633.
- [11]. 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.
- [12]. 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.
- [13]. 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.
- [14]. Nandakumar M, Nasim I. Comparative evaluation of grape seed and cranberry extracts in preventing enamel erosion: An optical emission spectrometric analysis. *J Conserv Dent.* 2018 Sep-Oct;21(5):516-520.Pubmed PMID: 30294113.
- [15]. Siddique R, Sureshbabu NM, Somasundaram J, Jacob B, Selvam D. Qualitative and quantitative analysis of precipitate formation following interac-

- tion of chlorhexidine with sodium hypochlorite, neem, and tulsi. *J Conserv Dent*. 2019 Jan-Feb;22(1):40-47. Pubmed PMID: 30820081.
- [16]. 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.
- [17]. 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.
- [18]. 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 nonendodontic specialists. *Indian J Dent Res*. 2018 Nov-Dec;29(6):716-720. Pubmed PMID: 30588997.
- [19]. 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.
- [20]. Rajakeerthi R, Nivedhitha MS. Natural Product as the Storage medium for an avulsed tooth—A Systematic Review. *Cumhur. Dent. J*. 2019;22(2):249-56.
- [21]. Azeem RA, Sureshbabu NM. Clinical performance of direct versus indirect composite restorations in posterior teeth: A systematic review. *J Conserv Dent*. 2018 Jan-Feb;21(1):2-9. Pubmed PMID: 29628639.
- [22]. Poorni S, Srinivasan MR, Nivedhitha MS. Probiotic strains in caries prevention: A systematic review. *J Conserv Dent*. 2019; 22(2):123-8.
- [23]. Siddique R, Nivedhitha MS. Effectiveness of rotary and reciprocating systems on microbial reduction: A systematic review. *J Conserv Dent*. 2019 Mar-Apr;22(2):114-122. Pubmed PMID: 31142978.
- [24]. Gilmour AS, Latif M, Addy LD, Lynch CD. Placement of posterior composite restorations in United Kingdom dental practices: techniques, problems, and attitudes. *Int Dent J*. 2009 Jun;59(3):148-54. Pubmed PMID: 19637523.
- [25]. Fusayama T. Total etch technique and cavity isolation. *J Esthet Restor Dent*. 1992 Jul;4(4):105-9.
- [26]. Kugel G, Ferrari M. The science of bonding: from first to sixth generation. *J Am Dent Assoc*. 2000 Jun;131 Suppl:20S-25S. Pubmed PMID: 10860341.
- [27]. Swift EJ Jr. Dentin/enamel adhesives: review of the literature. *Pediatr Dent*. 2002 Sep-Oct;24(5):456-61. Pubmed PMID: 12412960.
- [28]. Perdigão J, Geraldini S, Hodges JS. Total-etch versus self-etch adhesive: effect on postoperative sensitivity. *J Am Dent Assoc*. 2003 Dec;134(12):1621-9. Pubmed PMID: 14719760.
- [29]. Prati C, Pashley DH, Montanari G. Hydrostatic intrapulpal pressure and bond strength of bonding systems. *Dent Mater*. 1991 Jan;7(1):54-8. Pubmed PMID: 1901813.
- [30]. Perdigão J. Dentin bonding-variables related to the clinical situation and the substrate treatment. *Dent Mater*. 2010 Feb;26(2):e24-37. Pubmed PMID: 20005565.
- [31]. Lopes GC, Thys DG, Klaus P, Oliveira GM, Widmer N. Enamel acid etching: a review. *Compend Contin Educ Dent*. 2007 Jan 1;28(1):18-24.
- [32]. Kanca J 3rd. Resin bonding to wet substrate. 1. Bonding to dentin. *Quintessence Int*. 1992 Jan;23(1):39-41. Pubmed PMID: 1631269.
- [33]. Jacobsen T, Söderholm KJ. Some effects of water on dentin bonding. *Dental Materials*. 1995 Mar 1;11(2):132-6.
- [34]. Prabha JL, Ranjan M (2018) Effect of Total Etch on Enamel. *Res J Pharm Technol*. 11(6):2631-3.
- [35]. Frankenberger R, Lohbauer U, Roggendorf MJ, Naumann M, Taschner M. Selective enamel etching reconsidered: better than etch-and-rinse and self-etch? *J Adhes Dent*. 2008 Oct;10(5):339-44. Pubmed PMID: 19058678.
- [36]. Ermis RB, Temel UB, Celik EU, Kam O. Clinical performance of a two-step self-etch adhesive with additional enamel etching in Class III cavities. *Oper. Dent*. 2010 Mar;35(2):147-55.
- [37]. Beech DR, Jalaly T. Bonding of polymers to enamel: influence of deposits formed during etching, etching time and period of water immersion. *J Dent Res*. 1980 Jul;59(7):1156-62. Pubmed PMID: 6991561.
- [38]. Gateva N, Gusyiska A, Stanimirov P, Kabaktchieva R, Raichev I. Effect of etching time and acid concentration on micromorphological changes in dentin of both dentitions. *J IMAB*. 2016 Apr 5;22:1099-10.
- [39]. Swift EJ, Perdigão J, Heymann HO. Bonding to enamel and dentin: a brief history and state of the art, 1995. *Quintessence Int*. 1995 Feb 1;26:95.
- [40]. Ito S, Tay FR, Hashimoto M, Yoshiyama M, Saito T, Brackett WW, et al. Effects of multiple coatings of two all-in-one adhesives on dentin bonding. *J Adhes Dent*. 2005 Summer;7(2):133-41. Pubmed PMID: 16052762.
- [41]. Leinfelder K, Freedman G. Essentials of dentin bonding: clinical technique for long-term success. *Dent Today*. 2002 Feb;21(2):118-23. Pubmed PMID: 14509000.
- [42]. Poss SD. Successful application of total-etch and self-etch techniques in adhesive dentistry. *AEGIS Communications*. 2011;7.
- [43]. Catelan A, Mainardi MD, Soares GP, Lima AF, Ambrosano GM, Lima DA, et al. Effect of light curing protocol on degree of conversion of composites. *Acta Odontol. Scand*. 2014 Nov 1;72(8):898-902.
- [44]. Price RB, Shortall AC, Palin WM. Contemporary issues in light curing. *Oper. Dent*. 2014 Jan;39(1):4-14.
- [45]. Boksman L, Santos GC. Principles of light-curing. *Inside Dentistry*. 2012 Mar;8(3):94-7.