

Knowledge Attitude And Perception Of Regenerative Endodontic Procedure Among Specialist And Dental Practitioners

Research Article

Devika B¹, Dr J Mahalakshmi^{2*}

¹ Undergraduate Student, Saveetha Dental College and Hospitals, Saveetha Institute of Medical and Technical Sciences (SIMATS), Saveetha University, Chennai- 77, India.

² Senior Lecturer, Department of Conservative Dentistry and Endodontics, Saveetha Dental College and Hospitals, Saveetha Institute of Medical and Technical Sciences [SIMATS], Saveetha University, Chennai- 77, India.

Abstract

Introduction: Regenerative endodontic treatment is a procedure that involves disinfection of the root canal with the use of antibiotics. The purpose of pulp treatment is to maintain the tooth structure intact in order to preserve optimal function. Especially, in case of immature permanent teeth, maintaining the pulp vitality is essential for continuous root development and apical closure. The key elements of regenerative endodontic procedure are stem cells, growth factors and scaffolds.

Aim: The aim of the survey was to evaluate the knowledge, attitude and practice on regenerative endodontic procedure among dental practitioners and specialists.

Materials and Method: A survey was conducted across dental colleges of western part of India in February 2021. A questionnaire consisting of 20 questions was formulated. These questions can be divided into three parts, namely knowledge, attitude, and practice. Based on responses from the endodontic postgraduate students to this multiple choice-based questionnaire, the survey was analyzed.

Results: The present survey indicates that a very high percentage of the participants had a sound knowledge about regenerative endodontic procedure which means that such practices have gained a lot of recognition as compared to its status a decade ago. But those populations have done only a few cases of regenerative endodontic procedure. About 70.6% have done and the rest 29.6% have not done. This was because they didn't have enough knowledge regarding the procedure (63.6%) and they didn't have sufficient training on the procedure's growth factors (27.3%), disinfection of root canal (31.8%) and scaffold (27.3%). Both males and female population strongly agree that they don't have sufficient training regarding regenerative endodontic procedure, however, it is not statistically significant (p value= 0.227). Males strongly agree that success rate is the fear of patients whereas females think that higher cost is the fear, however, it is not statistically significant (p value= 0.060).

Conclusion: In this survey, the dental practitioners and endodontists have knowledge regarding certain aspects of the regenerative endodontic procedures but they lack knowledge in practical aspects. Training regarding the same can be done so as to facilitate the incorporation of regenerative endodontics in dental clinics.

Keywords: Regenerative Endodontic Procedure; Root Canal; Scaffold; Dental Practitioner and Specialist; Innovative Technique; Eco-Friendly.

Introduction

Regenerative endodontics is one of the most remarkable advancements in our specialty. The idea that one can replace damaged structures and regain functionality in previously necrotic and infected root canal systems has been groundbreaking. Regenerative endodontic treatment is a procedure that involves disinfection of

the root canal with the use of antibiotics [1]. The purpose of pulp treatment is to maintain the tooth structure intact in order to preserve optimal function [2]. Especially, in case of immature permanent teeth, maintaining the pulp vitality is essential for continuous root development and apical closure [3]. Immature Necrotic Permanent Teeth is removal of the necrotic pulp tissue from the canal with minimum canal preparation is required because the ca-

*Corresponding Author:

Dr. J Mahalakshmi,

Senior Lecturer, Department of Conservative Dentistry and Endodontics, Saveetha Dental College and Hospitals, Saveetha Institute of Medical and Technical Sciences [SIMATS], Saveetha University, Chennai- 77, India.

Tel: 9003080462

E-mail: mahalakshmi.j.sdc@saveetha.com

Received: September 13, 2021**Accepted:** September 23, 2021**Published:** September 24, 2021

Citation: Devika B, Dr J Mahalakshmi. Knowledge Attitude And Perception Of Regenerative Endodontic Procedure Among Specialist And Dental Practitioners. *Int J Dentistry Oral Sci.* 2021;8(9):4676-4682. doi: <http://dx.doi.org/10.19070/2377-8075-21000952>

Copyright: Dr. J Mahalakshmi©2021. This is an open-access article distributed under the terms of the Creative Commons Attribution License, which permits unrestricted use, distribution and reproduction in any medium, provided the original author and source are credited.

nal walls are thin and over-preparation can weaken the root structure, making it susceptible to fracture [4]. If the pulp of immature permanent teeth is infected, apexification that includes removal of the infected pulp and application of calcium hydroxide has been performed traditionally [5]. Traditional approaches of calcium hydroxide apexification and apical barrier techniques with mineral trioxide aggregate (MTA) have been used in the treatment of immature teeth with pulp necrosis though generally there is no further root development so the roots remain thin and fragile with a higher risk of fracture and tooth loss. Recently, it has been suggested that regenerative endodontic protocols (REPs) that utilize endogenous stem cells that are introduced in the canal by lacerating the periapical tissues to fill the canal with blood should be used for the treatment of immature teeth with pulp necrosis [6]. When the tooth is damaged by trauma, pulp regenerative endodontic treatment is performed because the pulp tissue is uninfected [7]. It results in complete root development after a short-term treatment procedure [8]. It has a high success rate. When compared with MTA apexification, studies have reported similar success and survival rates for regenerative endodontics, in the range of 90-100% [9]. It's a biologically based approach that induces bleeding from the periapical region into the canal, thus generating vital tissue that provides a natural defense against reinfection [10]. Radiographs such as periapical, bitewing and/or cone beam computed tomography are taken and plan is made for the treatment. It is designed to replace damaged structures, including dentin and root structures, as well as cells of the pulp-dentin complex [11]. Pulpal status and degree of root development are major factors in treatment planning for teeth requiring vital pulp treatment or root canal treatment [12]. Regenerative endodontic procedures are diverse and can include direct pulp capping, revascularization, apexogenesis, apexification, and even stem cell therapy and tissue engineering [13]. The key elements of regenerative endodontic procedure are stem cells, growth factors and scaffolds. Scaffolds are three-dimensional porous solid biomaterial. An ideal scaffold should be high porosity and an adequate pore size are necessary to facilitate cell seeding and diffusion throughout the whole structure of both cells and nutrients and should allow effective transport of nutrients, oxygen, and waste [14]. The scaffolds can be based on degradability of matrices, forms, presence or absence of cells and origin. There are also natural scaffolds, such platelet rich plasma and platelet rich fibrin [15]. There are various other techniques, root canal revascularization via blood clotting, postnatal stem cell therapy, pulp implantation, scaffold implantation, injectable scaffold delivery, three dimensional cell printing and gene delivery [15]. The difference between repair and regeneration is that it is completely necrotic tissue and after the treatment it closely resembles pulp tissue [16].

In a previous survey, practitioner interest in delivering regenerative endodontic procedures has been growing, with 96% of endodontists being willing to incorporate regenerative therapies into treatments [17]. In a previous survey, 156 endodontic postgraduate students were surveyed [18]. In another survey, 200 copies of the questionnaire were circulated, containing 23 questions regarding knowledge and opinions about the use of REPs and their application in a clinical scenario [19]. In another survey, 100 copies of a survey were circulated, and 56 completed surveys were returned anonymously [17]. In another survey, an online questionnaire comprising 20 questions was distributed amongst the dental professionals of Mangalore. A total of 448 dental professionals

responded [20]. A total of 105 responses were collected, Soft copies of the questionnaire were posted on online dental forms dedicated to dental postgraduates presently undergoing training in various colleges in India [21]. In another survey, a total of 850 participants completed the survey, representing a 20.9% response rate.

In future, regenerative endodontic procedures will become very popular and it is speculated to see unparalleled advances in this field. Hence, it is important to understand what the future endodontists think in this regard. Our team has extensive knowledge and research experience that has translated into high quality publications [22-41]. The aim of the survey was to evaluate the knowledge, attitude and practice on regenerative endodontic procedure among dental practitioners and specialists.

Materials and Methods

Study setting:

This survey was a prospective observational study. The advantages of this study were economical, easy to create, widespread, gather large data and quick interpretation. It involves homogeneous population, response bias and creates survey fatigue were the cons of the study. This study has been approved by the scientific review board, Saveetha dental College, Chennai.

Sampling for survey:

The sampling method for the survey conducted was simple random sampling. Sampling methods may contain a certain bias, hence measures are taken to minimise the sampling bias. The measures include checking internal and external validity, also by minimising error in question and avoiding leading questions.

Data collection:

A survey was conducted across dental colleges of western part of India in February 2021. A closed-ended questionnaire, comprising 21 questions were asked. The questions were validated. These questions can be divided into three parts, namely knowledge, attitude, and practice. Based on responses from the endodontic postgraduate students to this multiple choice-based questionnaire, the survey was analyzed. The survey was circulated using an online Google form link and the data was collected and represented in the pie chart using SPSS software (version 23). Regenerative endodontic treatment, endodontics, knowledge, pulp, scaffolds are the output variables.

Analytics:

A statistical test was used which is descriptive statistics, chi-square test, pie chart and bar diagram. P-value was found out and correlation and significance were established. Age, height, sex, neighbour, family and friends are the independent variables. Education, knowledge, attitude, perception and occupation are the dependent variables.

Results

Figure 1. Represents the distribution to know about regenerative endodontic procedure, where 59.52 % said yes (green), and 40.48% said no (blue).

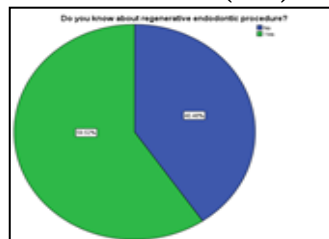


Figure 2. Represents the distribution of how many months does it take for a successful regenerative endodontic procedure, 15.48% said more than 12 months (blue), 33.33% of the people said that more than 3 months (green), 51.19% said that more than 6 months (brown).



Figure 3. Represents the distribution of participants based on the opinion on whether they have done regenerative endodontic procedure previously for their patients, where 77.38% responded yes (green) and 22.62% responded no (blue).

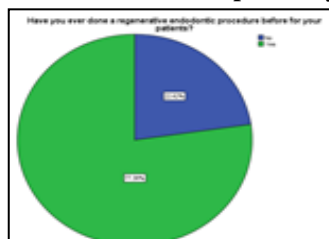


Figure 4. Represents the distribution of participants based on the opinion on whether regenerative endodontic procedure can serve as a feasible replacement of more aggressive treatment protocols, where 79.76% responded yes (green) and 20.24% responded no (blue).



Figure 5. Represents the distribution of challenges faced during regenerative endodontic procedure, where 8.33% said disinfection of root canal in immature teeth (blue), 22.6% said that growth factors (green), 39.29% said scaffolds (brown), 23.81% to obtain a sufficient no of autogenous cells (purple), 5.95% said unpredictable outcomes (yellow).



Discussion

This survey was employed to evaluate the awareness, understanding, attitude, and knowledge regarding regenerative endodontic procedures among the dental practitioners and specialists. Since most of the recent research is diverted toward stem cell and regenerative dental procedures, we think that it is deemed necessary to have a survey from general dental practitioners and endodontists to know the enthusiasm for the incorporation of regenera-

tive endodontic procedures into dental practices.

In the present survey, the age of the participants were asked. 63.10% were at the age of around 20-30 years, 27.38% of the respondents were between the age of 30-40 years and 9.52% of the respondents were above the age of 40 years. Out of 100 respondents, 54.8% were males and 45.2% were females. The number of years of experience as a dental professional was asked. For which, 47.6% of the respondents had 5-10 years of experience, 45.2% of

Figure 6. Bar charts representing association between gender and opinion on reason for not practising regenerative endodontic procedure. X axis represents gender and Y axis represents the number of participants who responded 'i don't have sufficient knowledge regarding regenerative endodontic procedure' (blue), 'i don't have sufficient training to perform the treatment' (green) and 'i have not encountered any case before' (brown). Both males and female population strongly agree that they don't have sufficient training regarding regenerative endodontic procedure, however, it is not statistically significant (Pearson's chi square value = 2.969, df= 2, p value= 0.227).

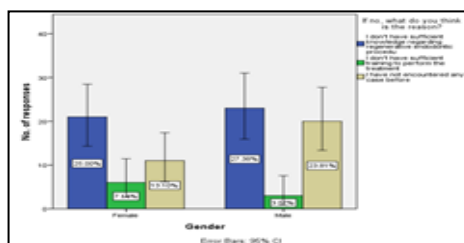


Figure 7. Bar charts representing association between gender and opinion on best treatment in regenerative endodontic procedure. X axis represents gender and Y axis represents the number of participants who responded 'immature apex with necrotic' (blue), 'periapical cyst with resolution' (green), 'persistent periapical infection' (brown) and 'root resorption' (purple). Both males and female population strongly agree that immature apex with necrotic is best in regenerative endodontic procedure, however, it is not statistically significant (Pearson's chi square value = 2.509, df= 3, p value= 0.474).

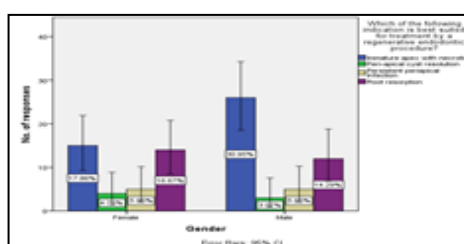
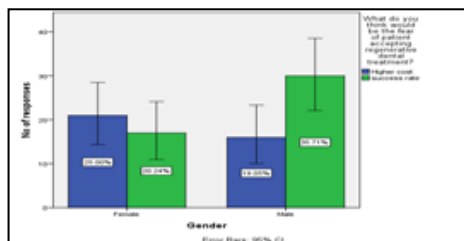


Figure 8. Bar charts representing association between gender and opinion on the fear of patients for not accepting regenerative endodontic procedures. X axis represents gender and Y axis represents the number of participants who responded 'higher cost' (blue) and 'success rate' (green). Males strongly agree that success rate is the fear of patients whereas females think that higher cost is the fear, however, it is not statistically significant (Pearson's chi square value = 3.542, df= 1, p value= 0.060).



the respondents had 0-5 years of experience and 7.1% said they had 5-10 years of experience. The specialisation of the dentist was asked and 44% of the respondents were dental practitioners, 41.7% of the respondents were dental specialists and 14.3% of the respondents were endodontists. When asked regarding the awareness of regenerative endodontic procedure, 59.5% said they were aware and 40.5% said no. Then we asked from where they knew about regenerative endodontic procedure. 38.1% said from conferences and seminars, 25% said they learnt it during their UG course, 15.5% said they learnt it during their PG course, 8.3% said from books and 6% were not aware about regenerative endodontic procedure. When the use of regenerative endodontic procedure was asked, 20.2% said Damaged dentine, 25% said Damaged pulp, 23.8% said Damaged enamel, 28.6% said all the above. When they know about regenerative endodontic procedures, 52.4% said Guided endodontic repair and 47.6% said True regeneration of physiological like tissue. A question regarding their knowledge on stem cells and its sources were asked. 63.1% were aware about stem cells and 36.9% said they were not aware. Regarding the sources of stem cells, 9.5% said dental pulp stem cell, 22.6% said stem cell from apical papilla, 23.8% said stem

cell from periodontal ligament, 26.2% said all of the above and 17.9% said not aware. When the duration of successful regenerative procedure was asked, 33.3% said more than 3 months, 51.2% said more than 6 months and 15.5% said more than 12 months. When asked whether they are aware that scaffold, stem cells and growth factor are included in regenerative endodontic procedure, 86.9% said yes and 13.1% said no. when asked about the opinion on whether regenerative endodontic procedure can serve as a practical and feasible replacement of more aggressive treatment protocols, 79.8% said yes and 20.2% said no. when asked whether they have done a regenerative endodontic procedure before for their patients, 77.4% said yes and 22.6% said no. When asked about the indication for the treatment by a regenerative endodontic procedure, 31% said root resorption, 48.8% said immature apex with necrotic, 11.9% said persistent periapical infection and 8.3% said periapical cyst resolution. When the reason for not practising regenerative endodontic procedure was asked, 52.4% said they don't have sufficient knowledge regarding regenerative endodontic procedure, 36.9% said they haven't encountered any case before and 10.7% they don't have sufficient training to perform the treatment. When asked about the assessment of regen-

S.NO	QUESTION	CHOICE	PERCENTAGE
1	Age	<ul style="list-style-type: none"> 20-30 30-40 Above 40 	<ul style="list-style-type: none"> 63.10% 27.38% 9.52%
2	Gender	<ul style="list-style-type: none"> Male Female 	<ul style="list-style-type: none"> 54.76% 45.24%
3	What is your specialisation?	<ul style="list-style-type: none"> Dental practitioner Dental specialist Endodontist 	<ul style="list-style-type: none"> 44.05% 41.67% 14.29%
4	Do you know about regenerative endodontic procedures?	<ul style="list-style-type: none"> Yes No 	<ul style="list-style-type: none"> 59.52% 40.46%
5	From where did you gain knowledge about regenerative endodontic procedure?	<ul style="list-style-type: none"> Books Conferences and seminars In PG course In UG course Internet Not aware 	<ul style="list-style-type: none"> 8.33% 38.10% 15.48% 25.00% 7.14% 5.95%
6	Regenerative endodontic procedure is replacement of	<ul style="list-style-type: none"> Damaged dentine Damaged enamel Damaged pulp All the above Not aware 	<ul style="list-style-type: none"> 20.24% 23.81% 25.00% 28.57% 2.38%
7	Regenerative endodontic procedure are	<ul style="list-style-type: none"> Guided endodontic repair process True regeneration of physiological tissue 	<ul style="list-style-type: none"> 52.38% 47.62%
8	Do you know about stem cells and their sources?	<ul style="list-style-type: none"> Yes No 	<ul style="list-style-type: none"> 63.10% 36.90%
9	What are the sources of stem cell?	<ul style="list-style-type: none"> Dental pulp stem cell Stem cell from apical papilla Stem cell from periodontal ligament All the above Not aware 	<ul style="list-style-type: none"> 9.52% 22.62% 23.81% 26.19% 17.86%
10	Are you aware that scaffold, stem cells and growth factors are included in regenerative endodontic procedure?	<ul style="list-style-type: none"> Yes No 	<ul style="list-style-type: none"> 86.90% 13.10%
11	How many months does it take for a successful regenerative endodontic procedure?	<ul style="list-style-type: none"> More than 3 months More than 6 months More than 12 months 	<ul style="list-style-type: none"> 33.33% 51.19% 15.48%
12	Have you ever done a regenerative endodontic procedure before for your patients?	<ul style="list-style-type: none"> Yes No 	<ul style="list-style-type: none"> 77.38% 22.62%
13	Do you think regenerative endodontic procedure can serve as practical and feasible replacement of more aggressive treatment protocol?	<ul style="list-style-type: none"> Yes No 	<ul style="list-style-type: none"> 79.76% 20.24%
14	If no, then what do you think is the reason?	<ul style="list-style-type: none"> I don't have sufficient knowledge regarding regenerative endodontic procedure I don't have sufficient training to perform the treatment I have not encountered any case before 	<ul style="list-style-type: none"> 52.38% 10.71% 36.90%
15	Which of the following indication is best suited for treatment by a regenerative endodontic procedure?	<ul style="list-style-type: none"> Immature apex with necrotic pulp Peri-apical cyst resolution Persistent peri-apical infection Root resorption 	<ul style="list-style-type: none"> 48.81% 8.33% 11.90% 30.95%
16	What do you think is the fear of patient accepting regenerative dental treatment?	<ul style="list-style-type: none"> Higher cost Success rate 	<ul style="list-style-type: none"> 44.05% 55.95%
17	What should the cost for regenerative dentistry be?	<ul style="list-style-type: none"> Equal to current treatment Less than current treatment More than current treatment Unsure 	<ul style="list-style-type: none"> 33.33% 21.43% 40.48% 4.76%
18	What do you think are the challenges faced during regenerative endodontic procedure?	<ul style="list-style-type: none"> Disinfection of root canal in immature teeth Growth factors Scaffolds To obtain a sufficient number of autogenous cells Unpredictable outcome 	<ul style="list-style-type: none"> 8.33% 22.62% 39.29% 23.81% 5.95%
19	What is your assessment of regenerative dental treatment outcome?	<ul style="list-style-type: none"> Successful Unsuccessful I don't know 	<ul style="list-style-type: none"> 39.29% 42.86% 17.86%

erative dental treatment outcomes, 39.3% said successful, 42.9% said unsuccessful and 17.9% said they didn't know. When asked about the challenge faced during regenerative endodontic procedure, 23.8% said to obtain a sufficient number of autogenous cells, 39.3% said scaffolds, 22.6% said growth factors, 6% said unpredictable outcomes.

In a previous survey, A total of 311 (69.12%) dental practitioners of which 69.14% (n = 215) were male and 30.87% (n = 96) were female had appropriately filled the questionnaires [42]. In a previous survey, results showed that 96.8% of dentists are willing to receive training to be able to provide regenerative endodontic procedures for their patients. Of the total group, 49.1% of dentists already use membranes, scaffolds, or bioactive materials to

provide dental treatment. It was determined that 47.3% of dentists agree that the costs of regenerative procedures should be comparable with current treatments. It was also found that 55.1% of dentists were unsure whether regenerative procedures would be successful [43]. In another survey, conducted by British Society of Paediatric Dentistry, the reasons for not using regenerative endodontic procedure was lack of training 45%, materials 26%, evidence 16% and suitable cases 6% [44]. In a previous survey, 66.2% of the respondents had not used any kind of regenerative procedures in their clinical practice, 54.3% were unaware of the treatment outcomes [45]. In a previous survey, 14.6% had used umbilical cord or other types of stem cell banking for themselves or a relative. But in our survey, the dental pulp stem cells were used. Two third of participants (74.6%) thought the greatest ob-

stacle to a patient accepting REP's would be higher cost of treatment, (12%) thought it would be fear of stem cell therapy and the remaining (13.3%) thought it would be due to other reasons [19]. There are several sources of stem cells in the oral cavity with some researchers implicating stem cells of the apical papilla (SCAP) as having a major role in RET [46]. Lovelace *et al.*, reported a 400–600-fold increase in mesenchymal stem cell markers in blood collected from the root canal [47]. In tissue engineering, a scaffold is an endogenous or transplanted material that provides a three - dimensional microenvironment promoting cell growth, differentiation, adhesion and migration [48]. Promoting a blood clot in RET has the advantage of transporting stem cells from the apical area into the root canal system whilst allowing these cells to differentiate in a three-dimensional manner. However, referring to a blood clot as a scaffold is controversial [49]. To disinfect the root canal system, minimal instrumentation of the canals was performed to prevent damage to the thin enamel walls followed by irrigation with 0.5% sodium hypochlorite and application of a bi-antibiotic paste containing 100 mg ciprofloxacin and 100 mg metronidazole to the root canal system [50].

Conclusion

Traditional root canal therapy of necrotic pulps is mechanically and materially based. Regenerative endodontic therapy is biologically based and intended to promote the host's natural wound healing process to restore vitality, immunity, and sensitivity of tissue in the canal space that was destroyed by infection or trauma. In order to harness this potential, the dental practitioners need to be aware and well informed regarding the same. This will allow the introduction of a new era in clinical endodontic dentistry that will help in preserving the vitality of the tooth. In this survey, the dental practitioners and endodontists have knowledge regarding certain aspects of the regenerative endodontic procedures but they lack knowledge in practical aspects. Training regarding the same can be done so as to facilitate the incorporation of regenerative endodontics in dental clinics.

Acknowledgement

We thank Saveetha Dental College, Saveetha University, SIMATS for supporting us to conduct the study.

Funding

This study was supported by the following agencies.

- Saveetha Dental College
- SIMATS, Saveetha University
- Virtusa Consultancy Services.

References

- [1]. Lee BN, Moon JW, Chang HS, Hwang IN, Oh WM, Hwang YC. A review of the regenerative endodontic treatment procedure. *Restor Dent Endod.* 2015 Aug 1;40(3):179-87.
- [2]. Banchs F, Trope M. Revascularization of immature permanent teeth with apical periodontitis: new treatment protocol?. *J. Endod.* 2004 Apr 1;30(4):196-200.
- [3]. Huang GJ. Apexification: the beginning of its end. *Int Endod J.* 2009 Oct;42(10):855-66.
- [4]. Frank AL. Therapy for the divergent pulpless tooth by continued apical formation. *J Am Dent Assoc.* 1966 Jan;72(1):87-93. Pubmed PMID: 5215726.
- [5]. Rafter M. Apexification: a review. *Dent Traumatol.* 2005 Feb;21(1):1-8.
- [6]. Diogenes A, Ruparel NB, Shiloah Y, Hargreaves KM. Regenerative endodontics: A way forward. *J Am Dent Assoc.* 2016 May;147(5):372-80. Pubmed PMID: 27017182.
- [7]. Shah N, Logan A, Bhaskar U, Aggarwal V. Efficacy of revascularization to induce apexification/apexogenesis in infected, nonvital, immature teeth: a pilot clinical study. *J Endod.* 2008 Aug 1;34(8):919-25.
- [8]. Horwani K, Sharma K. Platelet rich fibrin - a novel acumen into regenerative endodontic therapy. *Restor Dent Endod.* 2014 Feb;39(1):1-6. Pubmed PMID: 24516822.
- [9]. Torabinejad M, Nosrat A, Verma P, Udochukwu O. Regenerative endodontic treatment or mineral trioxide aggregate apical plug in teeth with necrotic pulps and open apices: a systematic review and meta-analysis. *J. Endod.* 2017 Nov 1;43(11):1806-20.
- [10]. Huang GT. Dental pulp and dentin tissue engineering and regeneration—advancement and challenge. *Front Biosci.* 2011 Jan 1;3:788.
- [11]. Feigin K, Shope B. Regenerative Endodontics. *J Vet Dent.* 2017 Sep;34(3):161-78.
- [12]. Wells C, Dulong C, McCormack S. Vital Pulp Therapy for Endodontic Treatment of Mature Teeth: A Review of Clinical Effectiveness, Cost-Effectiveness, and Guidelines [Internet]. Ottawa (ON): Canadian Agency for Drugs and Technologies in Health; 2019 Jul 10. Pubmed PMID: 31525010.
- [13]. Murray PE, Garcia-Godoy F, Hargreaves KM. Regenerative endodontics: a review of current status and a call for action. *J Endod.* 2007 Apr;33(4):377-90. Pubmed PMID: 17368324.
- [14]. Gathani KM, Raghavendra SS. Scaffolds in regenerative endodontics: A review. *Dent Res J.* 2016 Sep;13(5):379–86.
- [15]. Barbon S, Stocco E, Macchi V, Contran M, Grandi F, Borean A, et al. Platelet-Rich Fibrin Scaffolds for Cartilage and Tendon Regenerative Medicine: From Bench to Bedside. *Int J Mol Sci.* 2019 Apr 5;20(7):1701. Pubmed PMID: 30959772.
- [16]. Krafts KP. Tissue repair: The hidden drama. *Organogenesis.* 2010 Oct-Dec;6(4):225-33. Pubmed PMID: 21220961.
- [17]. Epelman I, Murray PE, Garcia-Godoy F, Kurtler S, Namerow KN. A practitioner survey of opinions toward regenerative endodontics. *J Endod.* 2009 Sep;35(9):1204-10. Pubmed PMID: 19720217.
- [18]. Das A, Nasim I. A knowledge, attitude, and practice survey among endodontic postgraduate students toward regenerative endodontic procedures. *Drug invent. today.* 2019 May 15;12(5).
- [19]. Utneja S, Nawal RR, Ansari MI, Talwar S, Verma M. A survey of attitude and opinions of endodontic residents towards regenerative endodontics. *J Conserv Dent.* 2013 Jul;16(4):314-8. Pubmed PMID: 23956532.
- [20]. Ariwala F, Yelapure M, Hegde MN, Devadiga D. Regenerative Endodontics-The Future? A Questionnaire Based Study. *Indian J Public Health Res Dev.* 2020 Jan 1;11(1) :363–8.
- [21]. Prasada LK, Bukhari SM. A survey on knowledge, attitude and beliefs of regenerative endodontics among postgraduate dental residents. *Al Ame en J Med Sci .* 2019;12(1):49-53.
- [22]. Muthukrishnan L. Imminent antimicrobial bioink deploying cellulose, alginate, EPS and synthetic polymers for 3D bioprinting of tissue constructs. *Carbohydr Polym.* 2021 May 15;260:117774. Pubmed PMID: 33712131.
- [23]. PradeepKumar AR, Shemesh H, Nivedhitha MS, Hashir MMJ, Arockiam S, Uma Maheswari TN, et al. Diagnosis of Vertical Root Fractures by Cone-beam Computed Tomography in Root-filled Teeth with Confirmation by Direct Visualization: A Systematic Review and Meta-Analysis. *J Endod.* 2021 Aug;47(8):1198-1214. Pubmed PMID: 33984375.
- [24]. Chakraborty T, Jamal RF, Battineni G, Teja KV, Marto CM, Spagnuolo G. A Review of Prolonged Post-COVID-19 Symptoms and Their Implications on Dental Management. *Int J Environ Res Public Health.* 2021 May 12;18(10):5131. Pubmed PMID: 34066174.
- [25]. Muthukrishnan L. Nanotechnology for cleaner leather production: a review. *Environ Chem Lett.* 2021 Jan 13;19(3):2527–49.
- [26]. Teja KV, Ramesh S. Is a filled lateral canal - A sign of superiority? *J Dent Sci.* 2020 Dec;15(4):562-563. Pubmed PMID: 33505634.
- [27]. Narendran K, MS N, SARVANAN A, SUKUMAR E. Synthesis, Characterization, Free Radical Scavenging and Cytotoxic Activities of Phenylvilangin, a Substituted Dimer of Embelin. *Indian J. Pharm. Sci.* 2020 Sep 1;82(5).
- [28]. Reddy P, Krithikadatta J, Srinivasan V, Raghu S, Velumserugan N. Dental Caries Profile and Associated Risk Factors Among Adolescents School Children in an Urban South-Indian City. *Oral Health Prev Dent.* 2020 Apr 1;18(1):379-386. Pubmed PMID: 32618460.
- [29]. Sawant K, Pawar AM, Banga KS, Machado R, Karobari MI, Marya A, et al. Dentinal Microcracks after Root Canal Instrumentation Using Instruments Manufactured with Different NiTi Alloys and the SAF System: A Systematic Review. *Appl. Sci.* 2021 Jan;11(11):4984.
- [30]. Bhavikatti SK, Karobari MI, Zainuddin SLA, Marya A, Nadaf SJ, Sawant VJ, et al. Investigating the Antioxidant and Cytocompatibility of Mimusops

- elengi Linn Extract over Human Gingival Fibroblast Cells. *Int J Environ Res Public Health*. 2021 Jul 4;18(13):7162. Pubmed PMID: 34281099.
- [31]. Karobari MI, Basheer SN, Sayed FR, Shaikh S, Agwan MAS, Marya A, et al. An In Vitro Stereomicroscopic Evaluation of Bioactivity between Neo MTA Plus, Pro Root MTA, BIODENTINE & Glass Ionomer Cement Using Dye Penetration Method. *Materials (Basel)*. 2021 Jun 8;14(12):3159. Pubmed PMID: 34201321.
- [32]. Rohit Singh T, Ezhilarasan D. Ethanolic Extract of *Lagerstroemia Speciosa* (L.) Pers., Induces Apoptosis and Cell Cycle Arrest in HepG2 Cells. *Nutr Cancer*. 2020;72(1):146-156. Pubmed PMID: 31149840.
- [33]. Ezhilarasan D. MicroRNA interplay between hepatic stellate cell quiescence and activation. *Eur J Pharmacol*. 2020 Oct 15;885:173507. Pubmed PMID: 32858048.
- [34]. Romera A, Peredpaya S, Shparyk Y, Bondarenko I, Bariani GM, Abdalla KC, et al. Bevacizumab biosimilar BEVZ92 versus reference bevacizumab in combination with FOLFOX or FOLFIRI as first-line treatment for metastatic colorectal cancer: a multicentre, open-label, randomised controlled trial. *The Lancet Gastroenterol Hepatol*. 2018 Dec 1;3(12):845-55.
- [35]. Raj R K, D E, S R. -Sitosterol-assisted silver nanoparticles activates Nrf2 and triggers mitochondrial apoptosis via oxidative stress in human hepatocellular cancer cell line. *J Biomed Mater Res A*. 2020 Sep;108(9):1899-1908. Pubmed PMID: 32319188.
- [36]. 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.
- [37]. Priyadharsini JV, 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 1;94:93-8.
- [38]. Uma Maheswari TN, Nivedhitha MS, Ramani P. Expression profile of salivary micro RNA-21 and 31 in oral potentially malignant disorders. *Braz Oral Res*. 2020 Feb 10;34:e002. Pubmed PMID: 32049107.
- [39]. Gudipaneni RK, Alam MK, Patil SR, Karobari MI. Measurement of the Maximum Occlusal Bite Force and its Relation to the Caries Spectrum of First Permanent Molars in Early Permanent Dentition. *J Clin Pediatr Dent*. 2020 Dec 1;44(6):423-428. Pubmed PMID: 33378468.
- [40]. Chaturvedula BB, Muthukrishnan A, Bhuvanaraghan A, Sandler J, Thiruvengkatachari B. *Dens invaginatus*: a review and orthodontic implications. *Br Dent J*. 2021 Mar;230(6):345-350. Pubmed PMID: 33772187.
- [41]. Kanniah P, Radhamani J, Chelliah P, Muthusamy N, Joshua Jebasingh Sathiy Balasingh Thangapandi E, et al. Green synthesis of multifaceted silver nanoparticles using the flower extract of *Aerva lanata* and evaluation of its biological and environmental applications. *ChemistrySelect*. 2020 Feb 21;5(7):2322-31.
- [42]. Blacher JD, Safavi KE, Aseltine RH, Kaufman BM. Defining Endodontic Residents' Clinical Experiences: A National Survey. *J Dent Educ*. 2019 May;83(5):504-509. Pubmed PMID: 30804173.
- [43]. Manguno C, Murray PE, Howard C, Madras J, Mangan S, Namerow KN. A survey of dental residents' expectations for regenerative endodontics. *J Endod*. 2012 Feb 1;38(2):137-43.
- [44]. Nazzal H, Tong H, Nixon P, Duggal M. Regenerative endodontic therapy for managing immature non-vital teeth: a national survey of UK paediatric dental specialists and trainees. *Br Dent J*. 2018 Feb 23;224(4):247-254. Pubmed PMID: 29472688.
- [45]. Lee JY, Kersten DD, Mines P, Beltran TA. Regenerative Endodontic Procedures among Endodontists: A Web-based Survey. *J Endod*. 2018 Feb;44(2):250-255. Pubmed PMID: 29229459.
- [46]. Hargreaves KM, Diogenes A, Teixeira FB. Treatment options: biological basis of regenerative endodontic procedures. *Pediatr. Dent*. 2013 Apr 15; 39(3 Suppl):S30-43.
- [47]. Lovelace TW, Henry MA, Hargreaves KM, Diogenes A. Evaluation of the delivery of mesenchymal stem cells into the root canal space of necrotic immature teeth after clinical regenerative endodontic procedure. *J Endod*. 2011 Feb;37(2):133-8. Pubmed PMID: 21238791.
- [48]. Nakashima M, Akamine A. The application of tissue engineering to regeneration of pulp and dentin in endodontics. *J. Endod*. 2005 Oct 1;31(10):711-8.
- [49]. Nazzal H, Kenny K, Altimimi A, Kang J, Duggal MS. A prospective clinical study of regenerative endodontic treatment of traumatized immature teeth with necrotic pulps using bi-antibiotic paste. *Int Endod J*. 2018 Apr;51 Suppl 3:e204-e215. Pubmed PMID: 28653761.
- [50]. Nicoloso GF, Pötter IG, Rocha RD, Montagner F, Casagrande L. A comparative evaluation of endodontic treatments for immature necrotic permanent teeth based on clinical and radiographic outcomes: a systematic review and meta-analysis. *Int J Paediatr Dent*. 2017 May;27(3):217-27.