



# Knowledge, Attitude, and Practice of Dentist's in Regenerative Endodontic Procedures: A Cross-sectional Online survey in India

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## Abstract

**Objective:** To study the level of awareness, current state of knowledge, and opinions towards regenerative endodontic procedures (REP's) amongst the dentists of India.

**Materials and Methods:** The questionnaire was formulated in Google Forms and distributed to 1300 dental practitioners electronically via a link through email and WhatsApp Messenger app across India.

**Results:** The survey yielded 951 responses (73%). Less than half of the practitioners were aware of umbilical cord stem cell banking (25.9%). Only 33.7% of practitioners had received continuing education on REP's. However, 88.9% of participants were willing to perform REP's in clinics, and 76.3% of them believe it should be included in regular practice over implant placement whenever possible.

**Conclusion:** The data showed that practitioners are willing to adapt REP's in practice. However, they lack awareness and knowledge regarding the procedure. There is a need for training workshops programs regarding the procedures. There is a need for training workshops programs regarding the procedures. There is a need for the establishment of more centers for stem cell collection to improve accessibility.

**Keywords:** Dental practitioner, India, practitioners' awareness, regenerative endodontics, survey

## Introduction

Dental pulp is a specialized connective tissue, consisting of blood vessels, nerves, odontoblasts, fibroblasts, and other cellular components. The pulp is uniquely secured by tough, mineralized dentin, serving multiple functions for the entire periodontium.[1] "Regenerative endodontic procedures (REP's) are biologically based procedures designed to physiologically replace the damaged tooth structure, including dentin and root

structures, as well as the pulp-dentin complex." (AAE 2016).[2,3] The mechanism of REP's involves the stimulation of undifferentiated mesenchymal cells to enter the root canal space by means of blood flow, and they become impregnated on the scaffolds to promote the maturation of an immature permanent tooth.[4]

Currently, available approaches for REP's include the cell-free (clinical *in vivo* approach) and cell-based (an *ex vivo* approach). Through cell-free approaches, endoge-

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nous stem cells like the periodontal ligament, apical papilla, or bone marrow, and not specifically the pulp tissue, are clinically feasible over the cell-based technique.

However, the cell-based approach involves particularly the dental pulp stem cells (DPSCs) derived from exfoliated deciduous teeth. These are then seeded onto scaffolds and transplanted into the canal space. Nevertheless, the barriers, like stem cell availability, its banking, cost, practice facilities, including the isolation and contamination, and the clinician's aptitude to perform transplants, restrict this approach.[5]

Currently, the ideal protocols for REP's case selection and procedure implementation are unclear to most general practitioners and specialized dentists as well. Apexification and endodontic therapies are much more accessible options over regenerative procedures. The responses will endorse the provision of ideal guidelines for REP's, making them a much more achievable and preferable option for most practitioners.

## Materials and Methods

A heterogeneous population of practitioners' opinions was required, and the most apt method of surveying was used in our study: a cross-sectional descriptive survey in the form of a pre-tested online questionnaire sent via a secured website. A probability sampling method was used to select a broad range of dental practitioners, and the data was analyzed via descriptive statistics of Likert scale responses from participants in percentages.

The questionnaire was approved by the institutional review board. Ethical approval was obtained from the ethical board of Mahatma Gandhi Dental College and Hospital, Jaipur (MGDCH/IEC/2023-24/T-18). An online pilot study was conducted among 60 (30 UG and 30 PG) students to check for the feasibility, reliability, and validity of the questionnaire. An invitation email, along with the final questionnaire, was circulated amongst all the dentists who were registered with the Indian Dental Association (IDA).

The questionnaire comprised three main sections. The first section included practitioner demographic data, along with their profile and educational background (undergraduates and postgraduates). The second section investigated the practitioner's existing knowledge, awareness, and attitude towards REP's. This section consisted of a set of 10 questions. The section gave us a preview of current knowledge regarding the standard operating procedures for REP's. This included the

banking of human stem cells and the importance of natural teeth over artificial replacements. The third section assessed existing clinical skills in terms of the usage of membranes, scaffolds, and bioactive materials. Also, this part gave insight into the clinical practice of REP's for the management of necrotic immature teeth, traumatic and avulsed teeth, and also included teeth with large periapical lesions. Lastly, the questionnaire addressed patient affordability and the futuristic aspects of the clinician's approach to procedure execution.

A questionnaire was sent to the participants as a link in a Google Form via email and the WhatsApp Messenger app. All the data were recorded and calculated in percentages.

Participants included in the study were both undergraduates (65.9%) and postgraduates (34.1%), aged <35 years (83.5%) and >35 years (16.5%), who were practicing more than 20 hours a week (70.4%), and were located diversely in the East (8.4%), West (30.5%), North (31.9%), and South (29.2%) regions of India.

The interview duration was nine months, from August 2023 to April 2024. The survey yielded 951 responses amongst 1300 respondents, excluding a 5% attrition rate.

To cut back on errors and bias, each of the participants was interviewed and interacted with by the same author. The personal identifiers were obscured from the online questionnaire. The author dealt with the respondents' refusal or withdrawal through reminder emails and messages at an interval of 3–4 days. A random sampling was done for the presented descriptive cross-sectional survey. Loss of data was controlled by marking the questions as 'mandatory to fill' for most of the questions in the Google Form.

## Results

The first section concerned the profile of participants and the demographic area of their practice. The second section concerned the knowledge, attitude, and practice of participants. The third section focused on the clinical application of regenerative endodontic procedures. The results in percentage are depicted as follows (Table 1).

### Profile of participants

6.5% of participants were less than 35 years old, and 83.5% were more than 35 years old. 58.6% of the respondents were male, and 41.3% were female. The demographics showed that 29.2% of participants were from the South India region, 31.9% were from North India, 30.5% belonged to West India, and 8.4% were

Table 1. Results of survey

| Profile of participants   |   |
|---|---|
| Age   | <35 yrs 16%<br>>35 yrs 83.5%  |
| Gender  | Male - 53.5%<br>Female - 46.5%  |
| Location-India  | North - 31.95<br>South - 29.2%<br>West - 30.5%<br>East - 10%                |
| Interviewee designation   | BDS - 65.9%<br>MDS - 34.1%  |
| Practiced hours per week  | <20hr/week - 29.6%<br>>20hr/week - 70.4%                                    |
| <b>Knowledge, attitude and opinion towards REP's</b>  |   |
| 1. Have you ever received continued education in stem cells and/or regenerative dental treatments?                                  | Yes - 33.7%<br>No - 66.3%   |
| 2. Should regenerative therapy be imported into dentistry ?   | Yes - 81%<br>No - 1.5%<br>Maybe - 17.5%                                     |
| 3. Have you or your relatives used umbilical cord or other types of stem cell banking?  | Yes - 25.9%<br>No - 65.1%<br>Maybe - 9.1%                                   |
| 4. How many years do you think it will take for some regenerative stem cell therapies to be used in dentistry?                      | 0-10years - 55.2%<br>10-20years - 36.55%<br>>21years - 7.5%<br>Never - 0.7% |
| 5. How many years do you think will take by dentist able to grow new teeth in laboratory ?  | 0-10years - 28%<br>10-11years - 37.6%<br>>21years - 31.4%<br>Never - 3%     |
| 6. Would you be willing to attend to training course and / or continuing education courses to apply regenerative dental treatments? | Yes - 79.7%<br>Unsure - 15.5%<br>No - Nil                                   |

**Table 1. Cont.**

| <b>Profile of participants</b>   |   |
|--|---|
| <b>Knowledge, attitude and opinion towards REP's</b>   |   |
| 7. Biggest obstacle for patient to accept REP's ?  | Higher cost – 83.8%<br>Other reason – 10.9%<br>Fear of stem cells – 5.3%  |
| 8. Would you willing to save teeth/dental tissue for REP's in near future?                             | Yes – 88.8%<br>Unsure – 9.1%<br>No – 0.3%   |
| 9. Do you think that regenerative dental treatment will be better option than tooth implant placement? | Yes – 76.3%<br>Unsure – 19.3%<br>No – 4.4%  |
| 10. Dentists should regulate the use of stem cells & Regenerative Dentistry ?                          | Yes – 83.4%<br>Unsure – 13%<br>No – 3.6%  |
| <b>Clinical application of REP's</b>   |   |
| 1. Practicing any type of regenerative procedure ?   | Yes – 55.4%<br>No – 44.6%   |
| 2. What is your assignment of regenerative dental treatment outcomes ?                                 | Successful – 50.9%<br>Don't know – 46.6%<br>Unsuccessful – 2.5%   |
| 3. After root canal treatment would the healing of periapical tissue be enhanced by REP's after?       | Yes – 63.1%<br>Unsure – 32.1%<br>No – 4.8%  |
| 4. Which of the following regenerative endodontic treatment is most valuable ?                         | All of the following – 65.1%<br>Pulp tissue revitalization within a root canal – 13.2%<br>Healing of periradicular bone – 9.9%<br>Continued root development in immature tooth – 7%<br>Tooth re-implantation – 4.8% |
| 5. What percentage of cases in your practice involves necrotic immature teeth?                         | Less than 10% – 54.4%<br>11–25% – 31.8%<br>26–50% – 9.5%<br>More than 50% – 4.3%  |

Table 1. Cont.

| Profile of participants  |   |
|--|---|
| Clinical application of REP's  |   |
| 6. What percentage of cases in your practice involves periradicular lesions?                               | Less than 10% – 13.8%<br>11–25% – 29.6%<br>26–50% – 35.1%<br>More than 50% – 21.6%  |
| 7. What percentage of cases in your practice involves avulsed or traumatized teeth?                        | Less than 10% – 65.7%<br>11–25% – 25.2%<br>26–50% – 7%<br>More than 50% – 2.1%  |
| 8. What do you consider to be the optimal treatment for necrotic immature teeth?                           | Calcium hydroxide application followed by MTA apical plug and backfill with obturation plug – 49.6%<br>Calcium hydroxide apexification – 19% MTA apical plug and backfill with obturation material – 16.3%<br>Tribiotic paste and pulpal regeneration – 15.1%<br>Yes – 66.3%<br>Unsure – 27.3%<br>No – 6.4% |
| 9. Would you be willing to collect dental tissue for stem cells banks?                                     | More to current treatment – 48.6%<br>Equal to current treatment – 30.6%<br>Unsure – 20.8%   |
| 10. What should be the cost of regenerative dentistry?   | If it is the most effective method – 54%<br>If it is safe and reliable – 33%<br>If it is most cost-effective method – 11.6%<br>I would never recommend it – 1.4%  |
| 11. What would make you most likely to recommend Stem cell regenerative dental treatment to your patients? |   |

from East India. The majority (70.4%) of dentists devote more than 20 hours per week to their clinical practice.

### **Knowledge, attitude, and opinion towards REP's**

The majority of participants (66.3%) hadn't received any continuing education regarding REP's. Only 33.7% of participants had received continuing education in stem cells and/or regenerative dental treatments; however, they were willing (81%) to incorporate regenerative endodontic therapy in dentistry. More than 74% of participants were not aware of any stem cell banking except for the umbilical cord.

55.2% of participants envisioned that within the next 10 years, regenerative stem cell therapies will be a frequent practice in dentistry. Moreover, some participants (37.6%) felt that in the next 11–20 years, it will be possible to grow a new tooth in a laboratory. For this reason, the majority of participants (79.7%) were willing to attend training in REP's. In contrast, two-thirds of participants (83.8%) thought that the cost would be the greatest obstacle for patients to accept REP's.

The majority of participants (88.9%) were willing to save dental tissues to be used in future REP's, and hence, three-fourths of the participants (76.4%) think that REP could be an even more successful and better treatment option than implants. Also, 83.3% of participants wanted the dental professional association (IDA) to include REP's in a routine academic curriculum.

### **Clinical application of REP's**

After detailed information about the knowledge, attitude, and opinion of a dentist towards REP's, further discussion about its clinical practice says that:

Around 44.6 percent of the participants are already practicing REP in some form, such as scaffolds, membranes, or bioactive materials, and are achieving favorable prognoses (46.6%) as well.

To this end, the majority of participants (63.1%) have added that the healing process of the periapical tissue is enhanced by REP's. Participants (65.1%) experienced that the healing of periapical bone is the most valuable factor in REP's, followed by the vitalization of pulp tissue within the root canal.

In terms of incidence, 54.3% of the clinicians reported seeing fewer than 10% of immature necrotic tooth cases in their practice. 35% of the clinicians experience up to 50% of cases with periradicular lesions, and 67.9% of clinicians have seen fewer than 10% of avulsed teeth cases in their practice.

In such cases, clinicians (49.4%) attempt a regenerating procedure by applying calcium hydroxide (CaOH), followed by an MTA apical plug and backfilling with obturation material, and find it a better treatment option.

Clinicians (66.3%) were willing to collect dental tissue for stem cell banking and suggested (46.7%) that the cost of REP's should be higher than the current treatment.

Clinicians (54%) recommend REP's to patients and found it to be the most effective treatment option compared to other treatments.

## **Discussion**

In 2007, the American Association of Endodontics approved the term "regenerative endodontics." [6] The other related terms, such as revascularization and revitalization, are used interchangeably. The regenerative endodontic procedures embrace all the procedures that attempt to restore and repair the physiological form of the damaged tissue.

A recent randomized controlled human clinical trial using umbilical cord mesenchymal stem cells (UC-MSCs) in plasma-derived biomaterial has been conducted. This reported positive clinical outcomes in terms of increased blood perfusion rate, infection resolution, positive pulp sensitivity tests, and continued radiographic root development. [7] The dental pulp stem cells (DP-SC) and stem cells of apical papillae (SCAP) are efficient in pulp regeneration, but the availability of these autologous cells is limited, whereas UC-MSC's are readily available from biobanks. UC-MSC's are also preferred over other non-dental stem cells like bone marrow mesenchymal/stromal stem cells (BMSC's) due to their high tolerance in HLA-matching (Human Leukocyte Antigen) between host and donor. [8,9]

Regardless of favorable outcomes, a complete pulp-dentin complex is yet to be regenerated in its functional native form.

The key outcomes yielded by survey responses are as follows:

### **Clinical practice outcomes**

Firstly, most of the practitioners' (49.6%) preferred method of REPs is the use of MTA for apexification or inducing blood clot formation and sealing of the cavity with MTA as a barrier.

Omer Hatipoglu et al [10] conducted a multinational survey of 13 countries and concluded that the most



commonly practiced methods of regenerative endodontics were MTA and blood clot.

A similar response was yielded by a web-based survey conducted by Lee [11] (2018) about regenerative endodontic procedures among endodontists.

Secondly, practitioners were not sure (46.6%) about the outcome of the treatment performed by themselves. This could be due to either poor patient compliance or the practitioners' lack of knowledge about outcome evaluation.

Although the standard guidelines regarding the evaluation of outcomes (clinically and radiographically) of REP's have been published by AAE and Chen et al,[12,13] they are still not followed by most practitioners.

### Knowledge outcome

The practitioners were oblivious regarding case selection and standard operating procedures (SOP) for regenerative endodontic therapies.[14,15] This is reflected in their single preferred method to perform REP's, i.e., by the use of MTA.

Based on the observations of experimental studies done by Kling et al;[16] Hoshino et al;[17] Nygard-Ostby and Hjortdal[18] Banchs and Trope described the protocol for revascularization of immature permanent teeth with apical periodontitis using triple antibiotic paste in 2004.[19]

### Awareness outcomes

The survey delineated that the protocols followed by practitioners were in contrast to the published guidelines.

A similar conclusion was reached by the HJ Tong (2021) online survey about regenerative endodontic therapy (RET) for managing immature non-vital teeth: experiences and opinions of pediatric dental practitioners in the European and Arabian regions.[20]

H. Nazzal (2018) has also observed, after the online survey about REP's amongst UK pediatric dental specialists and trainees, that the ideal guidelines were not followed in practice.[21,22]

### Futuristic prospects

54% of participants were willing to collect stem cells for banking (66.3%) and would like to recommend (54%) REP's in clinics if they are most effective. Also, if the safety and reliability of the procedure are assured, they would choose REP's whenever possible over any other treatment (33%).

### Clinical significance

For the implementation of guidelines, research funding, and worldwide standardization of REP's, it is important to know about the existing opinion, knowledge, and awareness amongst the practitioners. This survey included a large demographic area with variable participants, providing plenteous data.

### Limitations

Responses to the survey were based on subjective variability, as it is a web-based survey.

### Conclusion

Though REP's outcomes are very promising, cost-effective, and affordable, a disparity exists between the practice of REP's and the standard protocol amongst all dental practitioners in India. The guidelines for REP's should be made popular amongst practitioners by including REP's in the dental curriculum and by organizing continuing dental education programs (CDE). For the general population, natural tooth-saving procedures should be promoted through school dental health programs and community awareness events.

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