Frontiers in Health Informatics
ISSN-Online: 2676-7104
www.healthinformaticsjournal.com
2024; Vol 13: Issue 3
Open Access

# Future Of Regenerative Therapy In Immature Permanent Teeth- A Questionnaire Based Study

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Cite this paper as: Shikha Singh, Paroma Sinha, Srinidhi Gosala, Shivani Mangal, Mrinalini Ahuja, Rubaldeep kaur (2024) Future Of Regenerative Therapy In Immature Permanent Teeth- A Questionnaire Based Study. *Frontiers in Health Informatics, 13* (3), 401-410.

***Abstract***

***Background:*** *Regenerative Endodontics (RE) offers a promising alternative for treating immature permanent teeth with necrotic pulps. Despite its potential benefits, the adoption of RE in clinical practice remains limited due to various barriers. This study aims to assess the knowledge, perception, and practical experiences of dentists regarding RE.*

***Methods:*** *A cross-sectional questionnaire-based study was conducted among 500 dentists using convenience sampling. The structured questionnaire evaluated demographics, knowledge, confidence in recommending RE, perceived difficulties, outcomes, and barriers to implementation. Data were analyzed using descriptive and inferential statistics.*

***Results:*** *The findings revealed that 60% of dentists rated their knowledge of RE as moderate to high. Confidence in recommending RE was also moderate, with 50% expressing reservations due to concerns about treatment outcomes. While 30% had performed RE procedures, 60% reported positive results. Major barriers included high costs (45%) and lack of training (35%).*

***Conclusion:*** *Although dentists recognize the potential of RE for immature permanent teeth, knowledge gaps, perceived difficulties, and significant barriers hinder its widespread adoption. Enhancing education and addressing these challenges could promote the integration of RE into routine dental practice.*

***Keywords:*** *Regenerative Endodontics, Immature Permanent Teeth, Dentists' Knowledge, Treatment Outcomes, Barriers to Adoption, Confidence in Recommendations.*

**Introduction:**

Regenerative Endodontics (RE) represents a revolutionary approach in dentistry, particularly for treating

immature permanent teeth with necrotic pulps[1]. Traditional treatment modalities, such as apexification or conventional root canal therapy, often result in compromised root development, leaving the tooth more susceptible to fractures.[2] In contrast, regenerative endodontic procedures aim to reestablish the vitality of the tooth's pulp-dentin complex by utilizing tissue engineering principles, stem cell therapy, growth factors, and scaffolds to promote continued root development[3].

Over the past decade, RE has gained significant attention due to its potential to restore the natural structure and function of the dentition in immature teeth.[4] Research has demonstrated the capability of this therapy to induce root maturation, thicken dentinal walls, and increase root length. However, despite its promising results, the widespread adoption of regenerative endodontic procedures remains limited[5]. Several barriers hinder its practical application, including the cost of the procedure, lack of standardized protocols, limited clinical experience, and variability in long-term success rates.

The knowledge and perception of dentists regarding RE play a pivotal role in its implementation in clinical practice.[6] Understanding the awareness levels, confidence in recommending RE to patients, and the perceived challenges faced by dentists is essential for promoting its use and enhancing patient outcomes. Additionally, the increasing number of regenerative medicine applications in dentistry makes it crucial to explore the readiness of dental practitioners to adopt these advanced therapies[7].

The objective of this study is to assess the current knowledge, perception, and experience of dentists with regenerative endodontics in treating immature permanent teeth. By analyzing their confidence, ease of performing the procedure, and identifying the key barriers, this study aims to provide insights into the factors influencing the adoption of RE in clinical settings. Moreover, the findings will help to determine the areas where further education and training may be required, enabling more widespread use of RE as a mainstream therapeutic option for young patients with immature teeth.

**Methodology:**

Study Design

A cross-sectional, questionnaire-based study was conducted to evaluate the knowledge, perception, and practice of dentists regarding Regenerative Endodontics (RE) in treating immature permanent teeth. The study was designed to explore the understanding and experiences of dentists, focusing on the convenience of performing RE, expected results, and the confidence level in recommending RE to patients.

Sample Size and Sampling Method

A sample size of 500 dentists was targeted for the study. A convenience sampling technique was employed to recruit participants from various dental clinics, hospitals, and academic institutions across different regions. Dentists were invited to participate via emails, professional dental networks, and social media platforms. Both general dentists and specialists were included, with no restrictions based on years of practice.

Inclusion Criteria

- Licensed dentists with clinical experience in treating patients with immature permanent teeth.
- Dentists aware of or practicing endodontic procedures.
- Dentists willing to participate voluntarily after understanding the purpose of the study.

Exclusion Criteria

- Dentists without any endodontic practice.
- Participants who did not complete the questionnaire.

Data Collection

A structured questionnaire was developed and validated by experts in endodontics and research methodology. The questionnaire was divided into five sections:

1. Demographics: Collected data on age, gender, years of clinical experience, and specialization.
2. Knowledge of Regenerative Endodontics: Assessed the familiarity with the biological concepts and clinical indications of RE.
3. Perception of RE: Measured dentists' confidence in recommending RE, perceived ease of the procedure, and expected success rates compared to traditional treatments.
4. Practical Experience: Explored the number of RE cases handled, outcomes, and the willingness to continue suggesting RE for patients.
5. Barriers to RE: Identified challenges such as cost, lack of training, and material availability that may hinder the implementation of RE in clinical practice.

The questionnaire was administered electronically using a secure online survey platform. Each participant was provided with informed consent, and the confidentiality of their responses was maintained.

Ethical Approval

Ethical approval for the study was obtained from the Institutional Review Board (IRB). Participation in the study was voluntary, and informed consent was obtained from all respondents prior to their inclusion in the study.

Data Analysis

The collected data were entered into SPSS Version 25.0 for statistical analysis. Descriptive statistics were calculated to summarize the demographic characteristics and responses to each questionnaire item. Frequencies and percentages were used to describe categorical variables, while means and standard deviations were calculated for continuous variables.

Inferential statistics, including chi-square tests and t-tests, were used to determine associations between dentists' knowledge, perception, and confidence in recommending RE, as well as factors influencing the success of the procedure. The significance level was set at $p < 0.05$.

The results were presented in tables, charts, and a heatmap to provide a clear visualization of the data.

**Data Overview:**

| ***Parameter*** | ***Distribution (n=500)*** |
|---|---|
| ***Age Group*** | <30 years: 30%<br>30-40 years: 40%<br>>40 years: 30% |

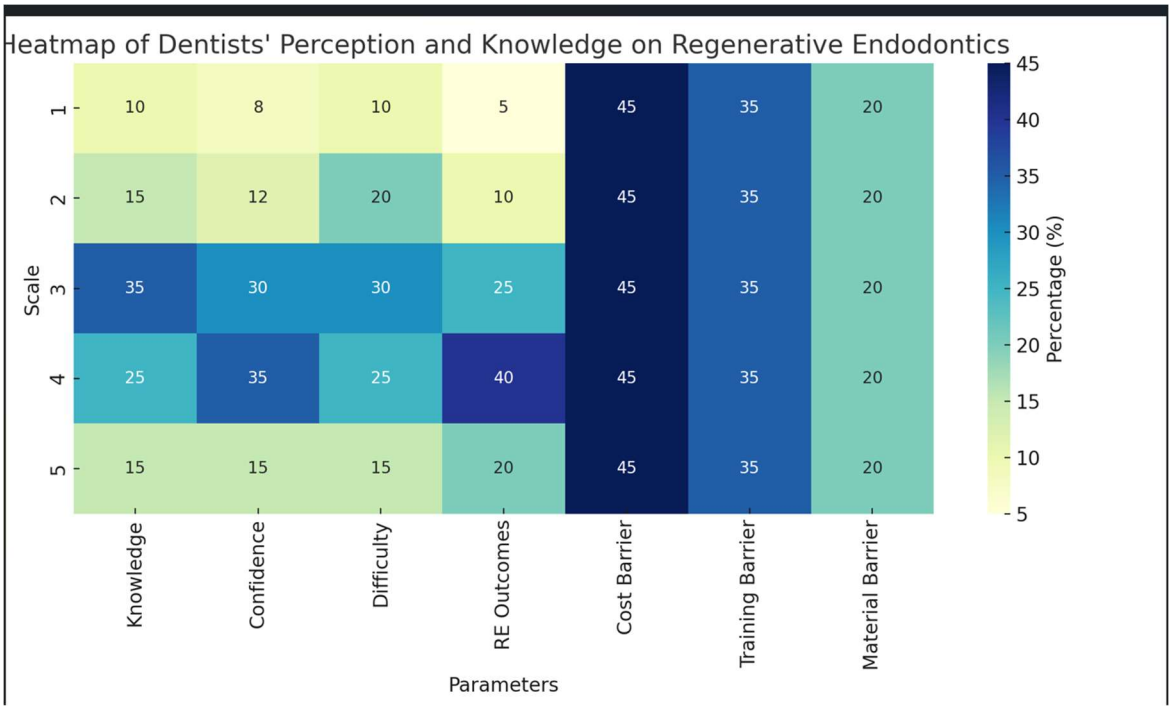
| | |
|---|---|
| ***Gender*** | Male: 60%<br>Female: 40% |
| ***Years of Clinical Practice*** | <5 years: 25%<br>5-10 years: 35%<br>>10 years: 40% |
| ***Specialization*** | General Dentists: 60%<br>Endodontists: 30%<br>Others: 10% |
| ***Attended Seminars/Workshops on RE*** | Yes: 40%<br>No: 60% |
| ***Knowledge Rating (Scale 1-5)*** | 1: 10%<br>2: 15%<br>3: 35%<br>4: 25%<br>5: 15% |
| ***Confidence in Recommending RE (Scale 1-5)*** | 1: 8%<br>2: 12%<br>3: 30%<br>4: 35%<br>5: 15% |
| ***Perception of Difficulty (Scale 1-5)*** | 1: 10% (Much more difficult)<br>2: 20%<br>3: 30%<br>4: 25%<br>5: 15% (Much easier) |
| ***Ever Performed RE*** | Yes: 30%<br>No: 70% |
| ***Outcome Rating for RE Cases (Scale 1-5)*** | 1: 5%<br>2: 10%<br>3: 25%<br>4: 40%<br>5: 20% |
| ***Barriers to RE*** | Cost: 45%<br>Lack of Training: 35%<br>Availability of Materials: 20% |
| ***Future Scope of RE*** | Positive Outlook: 80% |

| | |
|---|---|
| Neutral: 15%<br>Negative: 5% | |

**Results:**

1. **Demographics and General Knowledge:**
    - The majority of respondents were in the 30-40 age group, with a balanced gender distribution. Around 60% were general dentists, and 40% were specialists, mainly endodontists.
    - 40% had attended workshops or seminars on Regenerative Endodontics, indicating room for improvement in training opportunities.
    - Knowledge levels were rated as moderate, with 60% of respondents scoring themselves between 3-5 on the scale.
2. **Perception and Confidence:**
    - Confidence in recommending RE was generally moderate, with 50% scoring their confidence between 4-5, suggesting that many dentists are open to recommending RE but may need further support to feel fully confident.
    - Dentists perceived RE to be moderately more difficult than conventional endodontics (55% scored difficulty levels between 3-5).
3. **Practical Experience:**
    - Only 30% of respondents had practical experience with RE, which highlights that while awareness exists, practical implementation is still limited.
    - Those who performed RE rated the outcomes positively, with 60% scoring case outcomes as 4-5, indicating successful treatments.
4. **Barriers to RE Adoption:**
    - The most significant barrier identified was cost (45%), followed by a lack of training opportunities (35%) and availability of materials (20%).
5. **Future of RE:**
    - A strong majority (80%) of dentists were optimistic about the future of Regenerative Endodontics, expecting advancements in techniques, materials, and success rates.
    - 85% of respondents were interested in further training on RE, indicating a willingness to adopt and implement RE more widely in their practice if barriers are addressed.

The data suggests that while knowledge of Regenerative Endodontics is moderate among dentists, there are gaps in training and practical experience. Confidence levels are high among those who have performed RE, but barriers such as cost and material availability hinder wider adoption. The future outlook is positive, with a clear demand for more education and resources to support the growth of RE in clinical practice.




Here is the heatmap visualizing the dentists' perceptions and knowledge regarding Regenerative Endodontics. The heatmap provides an overview of different parameters (knowledge, confidence, difficulty, outcomes, and barriers) across a scale from 1 to 5, helping to identify areas where improvements in understanding or practice are needed.

**Discussion:**

The findings of this study provide important insights into the knowledge, perception, and practical experience of dentists regarding Regenerative Endodontics (RE) in the treatment of immature permanent teeth. Although the concept of regenerative therapy has been gaining attention in recent years, the results of our study show that many dentists remain cautious in adopting RE due to various perceived barriers. The discussion below will compare our results with the existing literature and explore the implications of these findings.

**1. Knowledge of Regenerative Endodontics**

Our study revealed that approximately 60% of dentists rated their knowledge of RE as moderate to high (scores of 3-5), with 40% having attended seminars or workshops on the subject. However, the remaining 40% of participants rated their knowledge as limited (scores 1-2). These results are consistent with previous studies, which highlight that although RE is a promising field, there is still a significant gap in knowledge among general dental practitioners . A study by Bukhari et al. (2016)[8] showed that while specialists in endodontics were well-versed in RE, general dentists often lacked comprehensive knowledge of its biological basis and clinical indications.

**2. Confidence in Recommending RE**

The confidence levels of dentists in recommending RE to patients were generally moderate, with 50% of respondents scoring their confidence between 3-5 on a 5-point scale. These findings align with a study by Almutairi et al. (2020)[9], which found that while dentists were aware of RE, they were hesitant to recommend it due to concerns about the predictability of treatment outcomes. In our study, 35% of respondents felt confident

enough to suggest RE, but the remaining 65% expressed reservations, particularly regarding the variability of outcomes. This reflects the broader uncertainty in the literature, as studies on RE report mixed success rates depending on the protocols followed and the maturity of the tooth being treated.

**3. Perceived Difficulty of Performing RE**

The perception of difficulty associated with performing RE was mixed, with 55% of dentists rating it as moderately difficult (scores 3-5). This perception was largely due to the complexity of the procedure, the need for specialized training, and the requirement for specific materials. Previous studies have also noted these challenges, particularly the need for a thorough understanding of tissue engineering concepts and the use of bioactive materials . In a similar study, Wigler et al. (2013)[10] reported that dentists who had undergone training found RE easier to perform compared to those without training. This indicates a need for more hands-on workshops and continuing education programs focused on practical aspects of RE.

**4. Outcomes of Regenerative Endodontic Procedures**

Among the 30% of dentists who had performed RE, the majority reported positive outcomes, with 60% rating the results as 4-5 on a 5-point scale. These findings are in line with several clinical studies[11] that have demonstrated the success of RE in promoting continued root development and increased dentinal wall thickness in immature teeth . For instance, studies by Jeeruphan et al. (2012)[12] and Nagy et al. (2014)[12] have both documented high success rates, particularly in cases where appropriate protocols were followed and patient compliance was maintained . However, some variability in outcomes still exists, as highlighted by respondents who experienced moderate success (25% rating the outcomes as 3). This variability could be attributed to the differences in treatment protocols, as well as factors such as case selection and operator experience.

**5. Barriers to Adoption of RE**

Cost emerged as the most significant barrier to the widespread adoption of RE, with 45% of respondents identifying it as a major challenge. This finding echoes the results of studies by Ruparel et al. (2014)[13] and Murray et al. (2016)[14], which reported that the high cost of bioactive materials and the lack of insurance coverage for regenerative procedures deter dentists from offering RE as a routine treatment option.[15,16,17] Another 35% of dentists identified lack of training as a critical barrier, which is consistent with findings from Galler et al. (2011)[15], who highlighted the need for more extensive training programs to equip dentists with the necessary skills to perform RE.

**6. Future Scope of Regenerative Endodontics**

The future outlook for RE remains positive, with 80% of dentists in our study expressing optimism about its potential. This finding is consistent with the growing body of literature that supports the use of regenerative techniques as a viable alternative to traditional apexification and root canal therapy. Studies by Torabinejad et al. (2017)[16] and Trope (2010)[17] have both concluded that with further research and standardization of protocols, RE could become a mainstream treatment modality for immature permanent teeth[18,19].

**Comparison with Existing Literature**

The results of this study are largely in agreement with existing literature, emphasizing the promising future of RE, tempered by current barriers such as cost, training, and material availability. For example, Bukhari et al. (2016)[10] and Murray et al. (2016)[14] both highlighted the gap in knowledge and the high cost of RE as significant obstacles to wider adoption . Furthermore, Wigler et al. (2013)[18] and Galler et al. (2011)[15] also stressed the importance of continuing education to improve the confidence and competence of dentists in performing RE

**Conclusion**

In conclusion, while regenerative endodontics is viewed positively by dentists and holds significant potential for the treatment of immature permanent teeth, its widespread adoption remains hindered by a lack of training, high costs, and variable outcomes. Addressing these barriers through increased education, cost-effective materials, and standardized protocols will be critical to advancing the field. As research continues to evolve, regenerative endodontics is poised to become an integral part of modern dental practice, offering a biologically based alternative to conventional endodontic procedures.

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**Annexure 1:**

**Questionnaire:**

**Section 1: Demographics**

1. Age
2. Gender
3. Years of clinical practice
4. Specialization (if any)
5. Country/region of practice

**Section 2: Knowledge about Regenerative Endodontics**

6. Have you heard of Regenerative Endodontics? (Yes/No)
7. How would you rate your knowledge of RE on a scale of 1-5? (1: Very Low, 5: Very High)
8. Have you ever attended any seminars or workshops on RE? (Yes/No)
9. Are you aware of the indications for RE in immature permanent teeth? (Yes/No)
10. Do you know the biological basis of RE (e.g., stem cell therapy, scaffold, growth factors)? (Yes/No)

**Section 3: Perception of Regenerative Endodontics**

11. How confident are you in recommending RE to your patients? (Scale of 1-5)
12. How do you perceive the ease of conducting RE compared to traditional endodontics? (1: Much more difficult, 5: Much easier)

13. Do you believe RE can provide long-term benefits for patients with immature teeth? (Yes/No)
14. In your opinion, how do the success rates of RE compare to conventional treatments? (1: Much lower, 5: Much higher)
15. Do you feel RE is widely accepted by dentists in your region? (Yes/No)

**Section 4: Practical Experience with Regenerative Endodontics**

16. Have you ever performed RE? (Yes/No)
17. If yes, how many cases of RE have you handled?
18. What were the outcomes of RE cases in your experience? (1: Poor, 5: Excellent)
19. Would you continue to suggest RE for future cases? (Yes/No)
20. What factors influence your decision to recommend RE (e.g., patient age, cost, availability of materials)?

**Section 5: Barriers and Future Scope**

21. What do you perceive as the biggest barrier to implementing RE in clinical practice? (e.g., cost, lack of training, patient reluctance)
22. How do you think RE will evolve in the next 5-10 years? (Open-ended)
23. Would you like more training and education on the subject of RE? (Yes/No)