ORIGINAL RESEARCH

Assessment of Knowledge, Attitude, and Practice Regarding Dental Stem Cells and Tooth Banking among Dental Professionals in Tamil Nadu: A Cross-sectional Study

Govindaraj Porkodi[1], G Karthi Priya[2], Selvaraj Vinodh[3], Muthusamy Manoharan[4], Mohanraj Kamatchi[5], Kruthika Murali[6]

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Abstract

Aims and background: The aim of this questionnaire study is to survey dental professionals on their knowledge, attitude, and practice (KAP) on dental stem cells (DSCs) and tooth banking.

Compared to other stem cell sources, DSCs are simple to produce and offer the added benefit of posing fewer ethical questions. As a result, tooth banking and DSC harvesting are becoming more and more common. Dental professionals must be knowledgeable about the benefits and drawbacks of DSCs in order to advise their patients on the subject [Katge et al., Indian J Dent Res. 2017;28(4):367–374]. This study aims to assess the KAP concerning DSCs and tooth banking among dental professionals. By evaluating these dimensions, we can gauge the readiness of the dental community to adopt these novel technologies and identify areas requiring further education and support.

Materials and methods: Pretested questionnaires were sent through Google Forms. The questionnaire consists of demographic details, with 21 questions which include 13 questions regarding knowledge, three questions regarding attitude, and five questions regarding practice on DSC and stem cell banking. 861 responses were obtained, the response data were analyzed, and the outcome was assessed.

Results: Mean scores were knowledge 7.26 ± 3.00, attitude 1.94 ± 0.90, and practice 2.99 ± 1.54. Overall, 66% were aware of DSCs, 73.7% identified their types, and 85.7% knew applications. Awareness of regenerative dentistry was 67.4%, while 62.1% knew about stem cell banks, and 61.4% knew the procedure. Notably, 71.5% would advise preservation, 67.9% were willing to invest, and 77% sought further training. Significant associations existed between KAP scores and demographics ($p < 0.05$).

Conclusion: The study underscores the need for enhanced educational efforts to improve knowledge and address ethical concerns surrounding DSCs. By targeting specific barriers and leveraging the positive attitudes of dental professionals, it is possible to foster greater adoption of this promising technology in clinical practice.

Clinical significance: Understanding dental professionals' KAP regarding DSCs and tooth banking highlights gaps in awareness and ethical clarity. Addressing these through targeted education and training can enhance the counseling of patients and promote the integration of stem cell banking and regenerative dentistry into routine clinical practice.

Keywords: Regenerative dentistry, Stem cell, Tooth banking.

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Introduction

The human body carries out numerous essential functions for survival and upkeep, one of which is the ability to heal and regenerate after injury or illness. This ability is made possible by a special group of undifferentiated cells called stem cells. Present in all the multicellular organisms, stem cells are capable of multiplying, producing identical copies of themselves, and transforming into various specialized cell types.[1]

Due to these properties, stem cells help significantly in the repair and regeneration of tissues and are being explored as potential treatments for multiple diseases such as Alzheimer's, heart disorders, rheumatoid arthritis, Parkinson's, and muscle degenerative conditions.[2]

Stem cells are categorized based on their ability to differentiate—totipotent, pluripotent, or multipotent—as well as their source: Either embryonic stem cells (ESCs) or adult stem cells (ASCs). ESCs are attained from blastocysts that are 4–5 days old; they are pluripotent, meaning they can give rise to stable cell lines and can become cells of mesoderm, ectoderm, and endoderm.[3]

Adult stem cells include both hematopoietic stem cells (HSCs) and mesenchymal stem cells (MSCs). HSCs can be isolated from peripheral blood, umbilical cord, or bone marrow. MSCs, which emerge from the fetal mesodermal layer, are also seen in various adult tissues such as dental stem cells (DSCs), liver stem cells, and skin stem cells.[2]

Among DSC, those from exfoliated teeth are the most favored due to their noninvasive and painless method of collection. These cells play a vital role in tooth regeneration, repair, and biological restoration.[4]

[1–6]Department of Pedodontics and Preventive Dentistry, Vivekananda Dental College for Women, Namakkal, Tamil Nadu, India

Corresponding Author: Govindaraj Porkodi, Department of Pedodontics and Preventive Dentistry, Vivekananda Dental College for Women, Namakkal, Tamil Nadu, India, Phone: +91 9788808978, e-mail: porkodigrm97@gmail.com

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Dental pulp stem cells (DPSCs) have the potential to convert into neural or vascular endothelial cells. They also express epithelial markers and can develop into adipogenic, chondrogenic, and osteogenic lineages, sharing several characteristics with neural stem cells.[5]

Therefore, understanding DSCs, their sources, kinds, preservation techniques, ethical issues, dental applications, preservation length, etc., is essential for using them in regenerative processes.[4] Dental professionals should have a clear understanding of the pros and cons of DSCs to properly inform and counsel their patients on the matter.[5]

According to the Occupational Safety and Health Administration's Bloodborne Infections Standard, humanoid teeth used for teaching and research are considered a likely source of blood-borne infections. The Centers for Disease Control and Prevention (CDC) recommends treating extracted teeth as possible carriers of blood-borne pathogens, as they are clearly a source of infection due to their origin within the human body. To minimize the risk of disease transmission, the CDC has established infection control guidelines for using extracted teeth in research and education, requiring that teeth be sterilized before use.[6] As a result, a dentist should be knowledgeable about the same.

Specialized knowledge and skills in this field are crucial because the advancements in DSC applications appear to be unmatched in the near future. To get the most out of DSCs in the upcoming years, it is necessary to learn more about them. In India, DSCs are in the emerging phase, and knowledge is lacking among professionals.[7] This study aims to assess the KAP concerning DSC and tooth banking among dental professionals. By evaluating these dimensions, we can gauge the readiness of the dental community to adopt these novel technologies and identify areas requiring further education and support.

Materials and Methods

Study Setting and Design

This observational, cross-sectional study was conducted among dental professionals practicing in Tamil Nadu, India, over a period from August to October month of the year 2024. Ethical clearance was obtained from the Institutional Ethics Committee (Ref. No. VDCW/IEC/350/2023). Participation was voluntary, and informed consent was obtained from all respondents prior to survey completion.

Study Population

The target population included dental professionals who had completed their Bachelor of Dental Surgery (BDS) degree or higher and were actively engaged in clinical practice within Tamil Nadu. Both male and female professionals were eligible for participation.

Sample Size Calculation

The required sample size was calculated using the formula for prevalence studies:

$$n = \frac{Z^2 \times p(1-p)}{d^2}$$

where Z = 1.96 at a 95% confidence level, p = 0.5 (assumed proportion in the absence of prior regional data), and d = 0.05 (allowable error). Substituting these values,

$$n = \frac{(1.96)^2 \times 0.5 \times 0.5}{(0.05)^2} = 384.16$$

Thus, a minimum of 385 participants was required. To improve representativeness and account for potential nonresponses, a larger sample size was targeted.

Sampling Strategy and Response Rate

A convenience sampling method was employed. A total of 1,063 dental professionals across Tamil Nadu were approached through professional networks, dental associations, and social media platforms. Of these, 861 participants completed the questionnaire, yielding a response rate of 81%. Attrition occurred in 202 cases due to incomplete responses or participant withdrawal, corresponding to an attrition rate of 19%. To enhance participation and reduce attrition, two reminder messages were circulated at 1-week intervals during the data collection period.

Questionnaire Development and Validation

The questionnaire was structured and prevalidated based on previously published literature. It contained 21 items divided into three domains: 13 questions on knowledge, three on attitude, and five on practice related to DSCs and tooth banking. Reliability of the tool was established through a test–retest method on 20 participants over a 2-week interval, yielding a correlation coefficient of 0.95. Internal consistency was measured using Cronbach's alpha, which was 0.90, indicating strong reliability. The pilot study participants were excluded from the final analysis.

Statistical Analysis

Statistical analysis was performed using Statistical Package for the Social Sciences (SPSS) Version 29 (SPSS Inc., Chicago, Illinois, United States). Descriptive statistics summarized demographics and responses, while the Chi-square tests assessed associations between KAP scores and demographics. A p-value <0.05 was considered significant.

Result

Tables 1 and 2 show that the majority of participants were aged 20–30 years (52.6%), followed by 30–40 years (39.5%), with most being BDS graduates (63.1%) as shown in Table 3. Table 2 indicates that 48.8% had 5–10 years of experience.

As seen in Table 4, the mean scores were knowledge 7.26 ± 3.00, attitude 1.94 ± 0.90, and practice 2.99 ± 1.54. Awareness of DSCs was reported by 66% of respondents, with 73.7% correctly identifying types and 85.7% knowing applications (Table 5). Awareness of

Table 1: Frequency and percentage of age-groups

Age-group	*Frequency*	*Percentage*
20–30	452	52.6
30–40	340	39.5
40–50	68	7.9
Total	860	100

Table 2: Frequency and percentage of years of experience

Years of experience	*Frequency*	*Percentage*
1–5	267	31.0
5–10	420	48.8
10–15	139	16.2
15–20	34	4.0

Table 3: Frequency and percentage of designation

Designation	*Frequency*	*Percentage*
BDS	543	63.1
MDS	317	36.9

regenerative dentistry was 67.4%, while 62.1% knew about stem cell banks, and 61.4% knew the banking procedure (Table 5).

Regarding preservation, 71.5% would advise storage, and 67.9% were willing to invest in DSCs (Table 5). Nondental applications were identified by 59.4%, and 49.4% acknowledged ethical concerns,

Table 4: Descriptive statistics of variables

Variables	*n*	*Minimum*	*Maximum*	*Mean ± SD*
Age	860	22	48	31.54 ± 5.673
Knowledge score	860	0	13	7.261 ± 3.002
Practice score	860	0	5	2.997 ± 1.545
Attitude score	860	0	3	1.946 ± 0.905

Table 5: Frequency and percentage of KAP questions

Questions	*Options*	*Frequency*	*Percentage*
Are you aware of the concept of DSCs?	No	292	34.0
	Yes	568	66.0
What are the different types of DSCs?	(a) Dental pulp stem	18	2.1
	(b) Stem cells from	10	1.2
	(c) Stem cells from	92	10.7
	(d) All of the above	634	73.7
	(e) Not aware of	106	12.3
Are you aware of various applications of DSCs?	No	123	14.3
	Yes	737	85.7
What are the different applications of DSCs?	(a) Whole tooth regeneration	20	2.3
	(b) Periodontal ligament	49	5.7
	(c) Regeneration of pulp/dentin	100	11.6
	(d) All of the above	545	63.4
	(e) Not aware of	146	17.0
Are you aware of the concept of Regenerative Dentistry based on DSCs?	No	280	32.6
	Yes	580	67.4
If given a chance, would you like to attempt Regenerative Dentistry based on DSCs in your clinical practice?	No	204	23.7
	Yes	656	76.3
Is preservation of DSCs important, even after preservation of umbilical cord stem cells?	No	270	31.4
	Not aware of it	187	21.7
	Yes	403	46.9
Can DSCs be used to develop nondental tissue?	No	243	28.3
	Not aware of it	220	25.6
	Yes	397	46.2
What are nondental applications of DSCs?	(a) Heart therapies	37	4.3
	(b) Brain tissue regeneration	39	4.5
	(c) Muscular dystrophy therapies	100	11.6
	(d) Bone regeneration	122	14.2
	(e) All of the above	511	59.4
	(f) None of the above	51	5.9
Are you aware of DSC banks in India?	No	326	37.9
	Yes	534	62.1
Which of the following are names of various stem cell banks in India?	(a) Stemade Biotech	48	5.6
	(b) Transcell Biologics Pvt. Ltd.	85	9.9
	(c) ReeLabs	153	17.8
	(d) All of the above	506	58.8
	(e) None of the above	68	7.9

Contd…

Contd…

Questions	*Options*	*Frequency*	*Percentage*
Do you know the procedure for DSC banking after extraction?	No	332	38.6
	Yes	528	61.4
Are there any ethical concerns regarding the use of stem cells in dentistry?	No	330	38.4
	Not	105	12.2
	Yes	425	49.4
The ethical guidelines related to DSCs are given by	(a) Indian Council of Medical Research	118	13.7
	(b) Dental Council of India	186	21.6
	(c) Medical Council of India	309	35.9
	(d) None of the above	216	25.1
	(e) Not aware of it	31	3.6
How long can you preserve DSCs?	(a) Lifelong	78	9.0
	(b) 10 years	307	35.7
	(c) 20 years	271	31.5
	(d) Not aware of it	204	23.7
Will you advise preservation or storage of DSCs?	No	245	28.5
	Yes	615	71.5
Are you willing to collect and invest in DSCs for preservation?	No	276	32.1
	Yes	584	67.9
What do you think are the obstacles for dental professionals in advising DSC therapy?	(a) High cost	62	7.2
	(b) Lack of awareness	70	8.1
	(c) Ethical issues	166	19.3
	(d) Insufficient knowledge among dental practitioners	163	19.0
	(e) All of the above	399	46.4
What do you think are the obstacles for patients in obtaining DSC therapy?	(a) High cost	38	4.4
	(b) Lack of awareness	89	10.3
	(c) Ethical issues	86	10.0
	(d) Insufficient	200	23.2
	(e) All of the above	447	52
What, according to you, are the ways to increase awareness of DSCs and their preservation?	(a) Seminars	59	6.8
	(b) Journals	50	5.8
	(c) Conferences and	58	6.7
	(d) Inclusion in the academic curriculum	92	10.7
	(e) Advertisements and public notice	115	13.4
	(f) All of the above	486	56.5
In the future, would you be interested in attending any workshop/ conference/seminar or CDE program about the applications of DSCs and tooth bank?	No	198	23.0
	Yes	662	77.0

though only 35.9% recognized the Medical Council of India as the guideline source.

Figures 1 to 3 depict comparative levels of KAP among dental professionals. Major obstacles reported were high cost, ethical issues, and insufficient knowledge (46.4%), while patient obstacles included high cost and lack of awareness (52%). Suggestions to improve awareness included seminars, journals, academic inclusion, and advertisements (56.5%), with 77% expressing interest in workshops or continuing education programs.

Associations between KAP scores and demographic variables are summarized in Table 6, with several showing statistically significant relationships ($p < 0.05$).

The values were compared using the Chi-square test. The study explored the KAP of dental professionals regarding DSCs. Among participants, a majority (66%) were aware of DSCs, their applications (85.7%), and regenerative dentistry (67.4%). However, ethical concerns and insufficient knowledge emerged as significant barriers. Preservation awareness was moderate, with 71.5% supporting it, but fewer (61.4%) knew the procedures involved. Obstacles for patients included cost and lack of awareness (52%). The findings highlighted the need for comprehensive education through seminars and workshops, as 77% of participants expressed interest in such programs. Associations showed younger professionals and those with less experience had comparatively lower awareness, indicating the need for targeted educational interventions. Overall, the study emphasizes enhancing awareness and addressing barriers to integrating DSC therapy into clinical practice effectively.

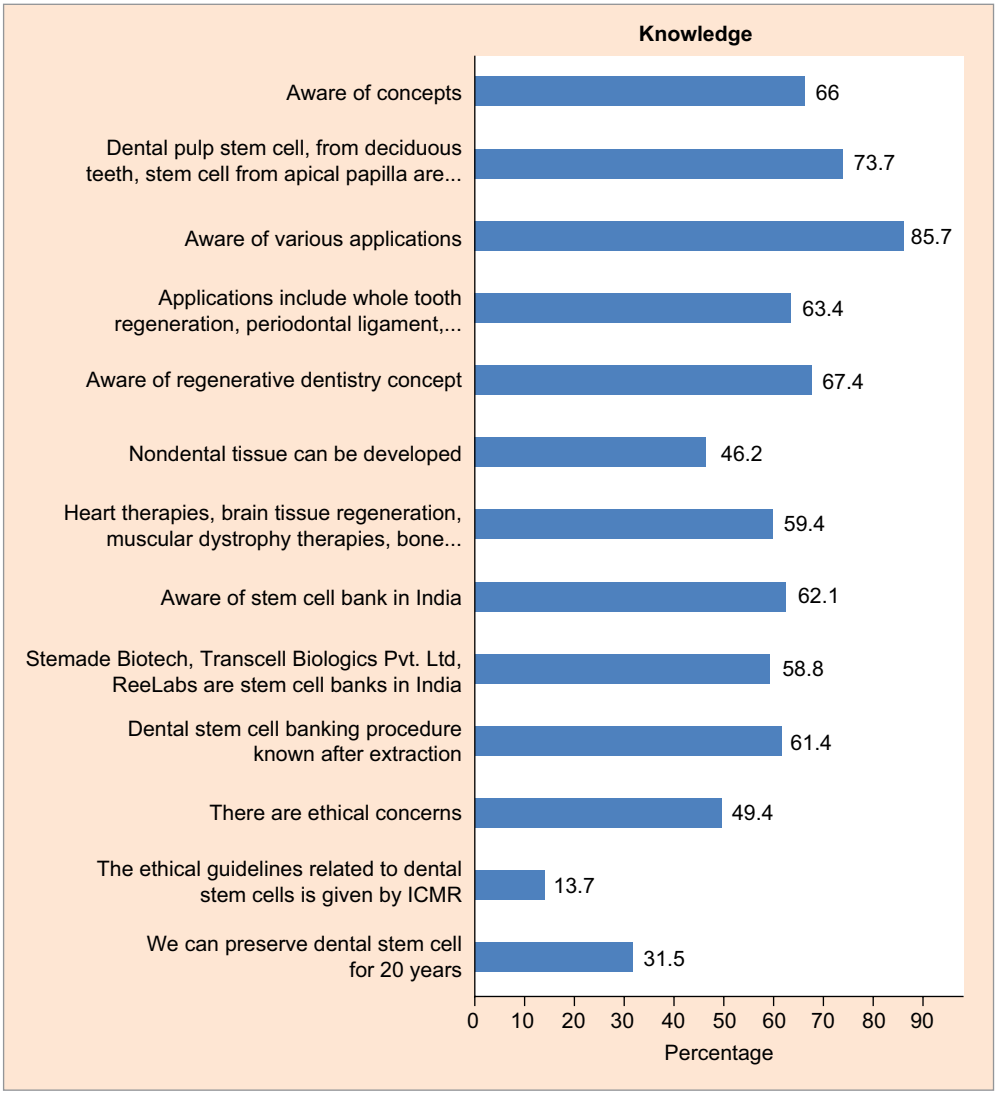


Fig. 1: Comparison of knowledge among dental professionals regarding DSCs and tooth banking

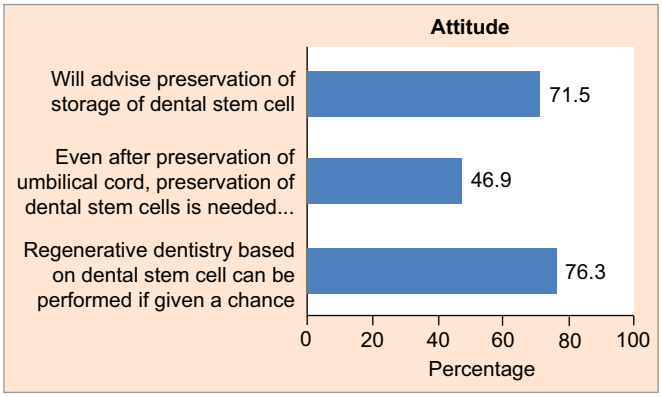


Fig. 2: Comparison of attitude among dental professionals regarding DSCs and tooth banking

Discussion

This study assessed the KAP of dental professionals in Tamil Nadu regarding DSCs and tooth banking, a field that is steadily gaining importance in regenerative dentistry. The overall response rate of 81% strengthens the validity of the findings. With an emphasis on identifying obstacles to their usage and methods to raise awareness, the current study sought to evaluate awareness, perspective, and practical implications among dentists about DSC and its benefits. The results also reflect information about how dental professionals now perceive and embrace these technologies of the same.

In this study, 66% of participants were aware of DSCs, and 73.7% could identify their types, while 85.7% knew about their applications. These results are comparable to Goswami et al., who reported 72% knowledge levels among Indian dental professionals regarding DSCs.[8] Similarly, Katge et al. observed that a majority of Indian dentists demonstrated moderate awareness of stem cell concepts.[5] However, in the present study, only 59.4% were aware of nondental applications, which is in line with Rahman et al., who found that professionals often recognized regenerative dental uses but had limited awareness of wider medical applications.[9] This highlights the need for structured educational modules focusing on both dental and nondental implications of stem cells.

Tooth banking, also known as DSC banking, is a process that involves the collection, preservation, and repository of dental tissues containing stem cells for potential future medical and dental treatments. Tooth banking typically involves the extraction and preservation of dental pulp or dental tissues from naturally

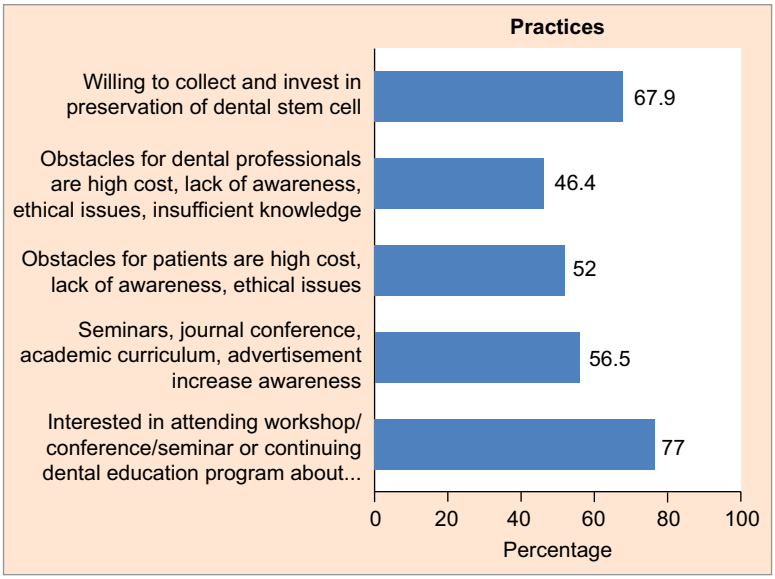


Fig. 3: Comparison of practice among dental professionals regarding DSCs and tooth banking

Table 6: Association of age-group, years of experience, and designation to KAP questions

Questions	*Age-group*	*Years of experience*	*Designation*
Are you aware of the concept of DSCs?	0.002*	0.103	0.020*
What are the different types of DSCs?	0.000**	0.000**	0.004*
Are you aware of various applications of DSCs?	0.047*	0.021*	0.000**
What are the different applications of DSCs?	0.338	0.249	0.270
Are you aware of the concept of Regenerative Dentistry based on DSCs?	0.041*	0.331	0.310
If given a chance, would you like to attempt Regenerative Dentistry based on DSCs in your clinical practice?	0.403	0.002*	0.094
Is preservation of DSCs important, even after preservation of umbilical cord stem cells?	0.131	0.001*	0.080
Can DSCs be used to develop nondental tissue?	0.631	0.055	0.909
What are nondental applications of DSCs?	0.461	0.000**	0.019*
Are you aware of DSC banks in India?	0.977	0.966	0.018*
Which of the following are names of various stem cell banks in India?	0.320	0.000**	0.071
Do you know the procedure for DSC banking after extraction?	0.003*	0.000**	0.180
Are there any ethical concerns regarding the use of stem cells in dentistry?	0.554	0.204	0.216
The ethical guidelines related to DSCs is given by	0.000**	0.000**	0.133
How long can you preserve DSCs?	0.091	0.153	0.032*
Will you advise preservation or storage of DSCs?	0.569	0.495	0.684
Are you willing to collect and invest in DSCs for preservation?	0.223	0.005*	0.572
What do you think are the obstacles for dental professionals in advising DSC therapy?	0.108	0.004*	0.169
What do you think are the obstacles for patients in obtaining DSC therapy?	0.001*	0.000**	0.002*
What, according to you, are the ways to increase awareness of DSCs and their preservation?	0.065	0.000**	0.014*
In the future, would you be interested in attending any workshop/ conference/seminar or CDE program about the applications of DSCs and tooth bank?	0.013*	0.000**	0.315

* Represents statistical significance levels; * $p < 0.05$ — statistically significant; ** $p < 0.001$ — highly significant

exfoliated deciduous teeth (baby teeth) or extracted permanent teeth. Since a major part of this extraction is done on immature or primary teeth, the role of tooth banking in pedodontics is crucial, and hence, pedodontists/pediatric dentists have an essential role to play in this process.[10] Over 61.4% have knowledge about DSC banking, which is higher when compared to Vishwanathaiah et al.'s study, where 66.43% were unaware of it.[11] The answers given to certain applications also demonstrated this knowledge gap.

Miura et al. stated that a reliable source of multipotent stem cells is SHED and holds significant promise in regenerative medicine.[6] The authors emphasize the need for further research to explore the specific role of SHED within the pulp cavities of deciduous teeth, as gaining insight into their function could enhance understanding and expand the potential applications of SHED in regenerative therapies.[12] The importance of sterilizing extracted human teeth before research or teaching use has been emphasized by Sandhu

et al. (2012), who compared different sterilization methods to minimize infection risk.[14]

Similarly, Smitha et al. (2014) found that undergraduate students showed limited awareness regarding safe handling of extracted human teeth, underscoring the need for better infection control training in dental education.[15] These findings correlate with the present study's observation that ethical and procedural knowledge regarding DSC handling remains inadequate among practitioners.

The present findings revealed a positive attitude among participants, with 71.5% willing to advise preservation of DSCs and 76.3% open to practicing regenerative dentistry. These results mirror the findings of Katge et al., where dentists expressed a willingness to integrate stem cell therapies if appropriate infrastructure and training were available.[5] Interestingly, nearly one-third of participants in the current study were unsure of the relevance of DSC preservation even after umbilical cord preservation, reflecting a knowledge gap also reported by Desai et al., who found that lack of understanding of preservation techniques influenced professional attitudes.[4]

In terms of practice, 67.9% of participants were willing to collect and invest in DSCs. However, major barriers identified were high cost (46.4%), insufficient knowledge (19%), and ethical concerns (19.3%). Similar barriers have been reported in earlier studies. Chitroda et al. found that 84% of professionals lacked awareness regarding ethical guidelines, with many expressing concerns about regulatory clarity.[7] According to Bates and Gallicchio (2021), dental stem cell banking offers emerging possibilities in tissue engineering and regenerative therapies, supporting the translational use of DSCs in routine clinical care.[16]

The findings underscore the importance of integrating DSC concepts into undergraduate and postgraduate curricula, as also suggested by Iglesias-Linares et al., who emphasized early training to prepare pediatric dentists for stem cell–based therapies.[13] Additionally, professional bodies should organize continuing dental education (CDE) programs and workshops, since 77% of participants in the present study expressed interest in such initiatives. The limitations of the present study include the use of convenience sampling, which may lead to selection bias, and restriction to dental professionals in Tamil Nadu, limiting external validity. The use of self-reported questionnaires introduces potential for recall and social desirability bias. Moreover, as a cross-sectional study, the findings capture knowledge and practices at a single point in time, without establishing causality.[17]

Despite these limitations, the study provides valuable insights into the readiness of dental professionals to adopt stem cell banking and regenerative dentistry. Bansal and Jain (2015) also reviewed the expanding scope of DSCs in regenerative dentistry, emphasizing their potential in the repair of dental and periodontal tissues.[17] Future multicentric and longitudinal studies with randomized sampling will help validate these findings across wider populations.

Conclusion

The study emphasizes the necessity of increased educational initiatives to advance understanding and resolve moral dilemmas related to DSCs. Greater adoption of this promising technology in clinical practice can be reinforced by focusing on particular obstacles and utilizing the positive attitudes of dental practitioners.

Data Availability

The datasets generated and analyzed during the current study are available from the corresponding author on reasonable request.

Author Contributions

Govindaraj Porkodi: Conceptualization, methodology, data collection, statistical analysis, manuscript drafting, and corresponding author responsibilities.
G Karthi Priya: Study design, questionnaire validation, manuscript review, and supervision.
Selvaraj Vinodh: Data analysis, interpretation of results, and manuscript editing.
Muthusamy Manoharan: Literature review, manuscript preparation, and critical revision.
Mohanraj Kamatchi: Validation, review of methodology, and manuscript proofreading.
Kruthika Murali: Data organization, review of references, and final manuscript approval.

All authors have read and approved the final manuscript.

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AI Disclosure

No artificial intelligence (AI)-assisted technologies were used in the preparation, analysis, writing, or editing of this manuscript.

Orcid

G Karthi Priya https://orcid.org/0009-0000-6981-3147
Mohanraj Kamatchi https://orcid.org/0009-0003-6370-016X

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