

# Knowledge, Attitude and Practice Regarding Dental Stem Cells and Tooth Banking among Dental Professionals: A Questionnaire-based Cross-sectional Study

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## ABSTRACT

**Introduction:** Stem cell therapy is new revolutionary technique which can repair many defects of human body. There are two sources of stem cells, one is embryonic and postnatal. Postnatal sites are the ones from which procuring stem cells is easiest. Dental stem cells from exfoliated deciduous teeth are also obtained from these sources. Dental health professionals must have understanding about dental stem cells for its application. Hence, there is need to evaluate knowledge, attitude and practice of dental professionals regarding dental stem cells.

**Aim:** To evaluate Knowledge, Attitude and Practice (KAP) regarding dental stem cells and tooth banking among dental professionals of Gujarat.

**Materials and Methods:** The study was a questionnaire based cross-sectional study conducted in the Department of Paediatric and Preventive Dentistry, KM Shah Dental College and Hospital, Sumandeep Vidyapeeth, Vadodara, Gujarat, India from December 2020 to March 2021. Total of dental health professionals participated including undergraduate (interns) and postgraduate students, dental practitioners and faculty members of dental colleges. Participants received the questionnaire in the form of a google form through email and WhatsApp. The data was analysed

using percentages of total and Chi-square test for statistical analysis.

**Results:** Out of 711 participants, 410 were students, 44 faculties, 207 practitioners and 50 faculties and practitioner both. Among the faculty, knowledge on types of dental stem cells was significantly associated with the years of experience ( $p$ -value  $<0.001$ ). Among the students, first year postgraduate students and interns had significantly less knowledge regarding various applications of dental stem cells ( $p$ -value  $<0.001$ ). Among them, 52.9% participants were aware of stem cell banks in India and 55.5% were aware of names of stem cell banks. Participants suggested that seminars, journals, academic curriculum, conferences or Continued Dental Education (CDE), and advertisement and public notice all should be used to increase awareness of dental stem cells among dental professionals.

**Conclusion:** There was adequate awareness among dental health professionals regarding dental stem cells and their applications but were unaware about tooth banking and its procedure. The study also found that there was lack of knowledge regarding steps of preservation of dental stem cells and their ethical concerns. Therefore, the topic of dental stem cells should be included in dental curriculum.

**Keywords:** Postnatal stem cells, Preservation, Umbilical cord cells

## INTRODUCTION

Human body is composed of millions of cells which are exposed to numerous ailments. Disease causes many defects in body which have to be healed for normal functioning of body. There are two ways in which healing occurs in our human body i.e. repair and regeneration [1]. Nature has assigned this task to specialised cells of our body that are known as stem cells, these are pluripotent in nature i.e. property to regenerate into different cells and parts of body as and when required [2,3]. Stem cells are of different types like chondrogenic (generate cartilage), osteogenic (generate bone), adipogenic (generate connective tissue), and neurogenic (generate neural tissue) [2]. Based on their potential to regenerate, stem cells are classified as totipotent, pluripotent, multipotent, oligopotent, or unipotent [3,4].

These cells can be acquired from two site embryonic or postnatal sites. Bone marrow, allograft, and dental stem cells are all postnatal sites. There are various types of dental stem cells which include Dental Pulp Stem Cells (DPSCs), Periodontal Ligament Stem Cells (PLSCs), Stem Cell From Apical Pulp (SCAP), Dental Follicular Precursor Cell (DFPC), and Stem Cells from Exfoliated Deciduous teeth (SHED) [5,6]. Among all these types, exfoliated deciduous teeth are most preferred because they have many added advantages like least traumatic technique, safest and has no side effects [7].

Exfoliated deciduous tooth stem cells have proved to have a greater differentiation capacity than other dental stem cells [8,9]. The laboratories preserving stem cells provide storage media and container in which clinician has to store exfoliated deciduous teeth. These cells are stored using cryopreservation under  $4^{\circ}\text{C}$  [10]. There are specialised dental stem cell banks which store these dental stem cells [11].

Dental stem cells are new road to regeneration as they are easy to obtain, less invasive and require lesser resources for collection. For utilisation of dental stem cells in regenerative process, knowledge regarding dental stem cells, their sources, types, method of preservation, ethical concerns, application in dentistry, duration of preservation, etc. is very necessary [12].

All dental health professionals starting from students to faculty and professionals play an important role in creating awareness and break the stigma regarding application of dental stem cells. On literature search as there are very few studies found [12-17] regarding knowledge, attitude and practice of dental stem cells and tooth banking. Most of the studies focused on dental stem cells and ignored stem cell banking [12-13]. Thus, there is a need to assess the level of knowledge regarding use of dental stem cells and available tooth banking systems in India. The aim was to evaluate

and compare knowledge, attitude and practice regarding dental stem cells and tooth banking among dental professionals.

## MATERIALS AND METHODS

The study was a questionnaire based cross-sectional study conducted in the Department of Paediatric and Preventive Dentistry, KM Shah Dental College and Hospital, Sumandeep Vidyapeeth, Vadodara, Gujarat, India from December 2020 to March 2021, after obtaining approval from Institutional Ethics Committee. Convenience sampling technique was used and sample size was calculated based on Sede MA et al. (2013) [12]. Out of 1000, a total of 711 dental health professionals completed the questionnaire.

**Inclusion and Exclusion criteria:** The target population included undergraduate (interns) and postgraduate students, dental practitioners and faculty members of dental colleges of Gujrat. Participants who didn't give consent to fill questionnaire or filled an incomplete questionnaire were excluded from the study.

### Questionnaire

Questionnaire was prepared based on studies and validated by subject expert [12-15]. Reliability of the questionnaire was tested using test-retest method at two week interval on a sample of 20. They were excluded from final sample. The test-retest correlation coefficient was +0.95. For the internal consistency between items of questionnaire, Cronbach's  $\alpha$  was calculated. The Cronbach's  $\alpha$  was found to be +0.90. The questionnaire was checked for Face validity and Content Validity by five subject experts. More than half of the experts rated the questions essential. Content validity ratio for every item and average content validity ratio was calculated from the responses of the expert. The content validity ratio was found to be 0.78 at p-value <0.05. Participants received the questionnaire in the form of a google form via email and whatsapp. The survey form consisted of two parts in which first part included demographic data, introduction to the study and consent form and second part consisted of questionnaire. Questionnaire consisted of 21 questions among which 13 for knowledge, three for attitude and five for practice regarding dental stem cells and stem cell banking [Annexure 1]. The participants, who didn't fill the questionnaire within 15 days, were reminded three times for filling the questionnaire at the interval of 15 days.

## STATISTICAL ANALYSIS

The participant's responses were entered into Microsoft Excel 2018. The analysis was done using Statistical Package for Social Sciences software version 21.0 software (SPSS Inc., Chicago, IL, USA). The data was analysed using percentages of total and Chi-square test for statistical analysis. A p-value <0.05 is considered to be significant.

## RESULTS

A total of 711 people completed the questionnaire, among which 499 were women and 212 were men. Out of 711 participants 410 were students, 44 faculties, 207 practitioners and 50 faculties and practitioner both. Amongst students 158 interns (undergraduates), 88 first year postgraduate students, 118 second year postgraduate students and 46 third year postgraduate students had participated. [Table/Fig-1].

Among the participants with work experience of >10 years had statistically more knowledge on dental stem cells (p-value=0.002). Among the students, first year postgraduate students and interns had significantly less knowledge regarding various applications of dental stem cells (p-value <0.001). It was found that professionals with work experience less than 5 years had significant less knowledge regarding different types and applications of dental stem cells (p-value <0.001). Interns also had less knowledge on different applications of dental stem cells (p-value <0.001) [Table/Fig-2].

Higher percentage of professionals with >10 years of experience responded that it is important to preserve the stem cells even after preservation of umbilical cord stem cells (p-value <0.001). For students, second and final year MDS students were more aware about preserving dental stem cells even after preservation of umbilical cord stem cells (p-value <0.05) [Table/Fig-3].

According to participants high cost, ethical issues and insufficient awareness among patients regarding dental stem cells, all are factors which are obstacle for patients obtaining dental stem cells therapy and was statistically significant [Table/Fig-4]. Participants suggested that seminars, journals, academic curriculum, conferences or CDE, and advertisement and public notice all should be used to raise dental practitioners' awareness regarding dental stem cells and tooth banking [Table/Fig-4].

Gender		Students		Faculty and practitioners			Experience of faculty		
Male	Female	Undergraduate student	Postgraduate student	Faculty	Practitioner	Faculty and practitioner both	Less than 5 years	5-10 years	More than 10 years
212	499	158	252	44	207	50	137	116	48
711		410		301			301		
		711							

[Table/Fig-1]: Demographic data of the participants.

Questions	Categories	Experience			p-value	Year of study (For students)				p-value
		<5 years n=137 n (%)	5-10 years n=116 n (%)	>10 years n=48 n (%)		1 <sup>st</sup> year PG n=88 n (%)	2 <sup>nd</sup> year PG n=118 n (%)	3 <sup>rd</sup> year PG n=46 n (%)	Intern n=158 n (%)	
Are you aware of the concept of dental stem cells?	a) Yes	115 (83.9)	108 (93.1)	48 (100)	0.002	82 (93.20)	112 (94.90)	42 (91.30)	140 (88.60)	0.278
	b) No	22 (16.1)	8 (6.9)	0 (0)		6 (6.80)	6 (5.10)	4 (8.70)	18 (11.40)	
What are different types of dental stem cells?	a) Dental pulp stem cells	19 (13.9)	8 (6.9)	0 (0)	<0.001	10 (11.40)	12 (10.20)	0 (0)	14 (8.90)	0.116
	b) Stem cells from shedded human milk teeth	2 (1.5)	16 (13.8)	0 (0)		6 (6.8)	4 (3.40)	4 (8.70)	6 (3.80)	
	c) Stem cells from apical papilla/ Stem cells from tissue beneath the tooth	4 (2.9)	26 (22.4)	0 (0)		2 (2.3)	3 (2.50)	4 (8.70)	10 (6.30)	
	d) All of the above	94 (68.6)	60 (51.7)	48 (100)		62 (70.50)	89 (75.40)	30 (65.20)	104 (65.80)	
	e) Not aware about it	18 (13.1)	6 (5.2)	0 (0)		8 (9.10)	10 (8.50)	8 (17.40)	24 (15.20)	

Are you aware of various applications of dental stem cells?	a) Yes	115 (83.9)	90 (77.6)	46 (95.8)	0.016	50 (56.80)	103 (87.30)	40 (87.0)	100 (63.30)	<0.001
	b) No	22 (16.1)	26 (22.4)	2 (4.2)		38 (43.20)	15 (12.70)	6 (13.0)	58 (36.70)	
What are different applications of dental stem cells?	a) Whole tooth regeneration	4 (2.9)	4 (3.4)	2 (4.2)	<0.001	0 (0)	2(1.70)	0 (0)	6 (3.80)	<0.001
	b) Periodontal ligament, cementum, alveolar bone/ tooth supporting structures regeneration	18 (13.1)	14 (12.1)	2 (4.2)		12 (13.60)	4 (3.40)	6 (13.0)	32 (20.30)	
	c) Regeneration of pulp/dentin	13 (9.5)	30 (25.9)	2 (4.2)		16 (18.20)	21 (17.80)	6 (13.0)	14 (8.90)	
	d) All of the above	76 (55.5)	52 (44.8)	42 (87.5)		48 (54.50)	83 (70.30)	28 (60.90)	78 (49.40)	
	e) Not aware about it	26 (19)	16 (13.8)	0 (0)		12 (13.60)	8 (6.80)	6 (13.0)	28 (17.70)	
Are you aware of concept of Regenerative Dentistry based on dental stem cells?	a) Yes	103 (75.2)	100 (86.2)	48 (100)	<0.001	72 (81.80)	100 (84.70)	40 (87.0)	124 (78.50)	0.442
	b) No	34 (24.8)	16 (13.8)	0 (0)		16 (18.20)	18 (15.30)	6 (13.0)	34 (21.50)	
Can dental stem cells be used to develop non dental tissue?	a) Yes	78 (56.9)	64 (55.2)	36 (75)	<0.001	40 (45.50)	43 (36.40)	24 (52.20)	72 (45.60)	0.006
	b) No	10 (7.3)	28 (24.1)	4 (8.3)		2 (2.30)	8 (6.80)	8 (17.40)	18 (11.40)	
	c) Not aware about it	49 (35.8)	24 (20.7)	8 (16.7)		46 (52.30)	67 (56.80)	14 (30.40)	68 (43.0)	
What are non dental applications of dental stem cells?	a) Heart therapies	4 (2.9)	2 (1.7)	0 (0)	0.012	4 (4.50)	2 (1.70)	0 (0)	4 (2.50)	0.008
	b) Brain tissue regeneration	0 (0)	2 (1.7)	0 (0)		0 (0)	0 (0)	0 (0)	2 (1.30)	
	c) Muscular dystrophy therapies	2 (1.5)	12 (10.3)	4 (8.3)		10 (11.40)	0 (0)	2 (4.3)	8 (5.10)	
	d) Bone regeneration	24 (17.5)	22 (19)	6 (12.5)		18 (20.50)	21 (17.80)	10 (21.70)	46 (29.10)	
	e) All of the above	90 (65.7)	54 (46.6)	26 (54.2)		38 (43.20)	74 (62.70)	26 (56.50)	80 (50.60)	
	f) None of the above	17 (12.4)	24 (20.7)	12 (25)		18 (20.50)	21 (17.80)	8 (17.40)	18 (11.40)	
Are you aware of dental stem cell banks in India?	a) Yes	64 (46.7)	82 (70.7)	38 (79.2)	<0.001	38 (43.20)	64 (54.20)	30 (65.20)	60 (38.0)	0.003
	b) No	73 (53.3)	34 (29.3)	10 (20.8)		50 (56.80)	54 (45.80)	16 (34.80)	98 (62.0)	
Which of the following are names of various stem cell banks in India?	a) Stemade Biotech	14 (10.2)	6 (5.2)	6 (12.5)	<0.001	12 (13.60)	6 (5.10)	4 (8.70)	28 (17.70)	0.001
	b) Transcell Biologics Pvt. Ltd.	10 (7.3)	8 (6.9)	4 (8.3)		8 (9.10)	17 (14.40)	4 (8.70)	16 (10.10)	
	c) Ree Labs	12 (8.8)	30 (25.9)	0 (0)		4 (4.50)	2 (1.70)	4 (8.70)	4 (2.50)	
	d) All of the above	76 (55.5)	52 (44.8)	36 (75)		38 (43.20)	79 (66.90)	26 (56.50)	88 (55.70)	
	e) None of the above	25 (18.2)	20 (17.2)	2 (4.2)		26 (29.50)	14 (11.90)	8 (17.40)	22 (13.90)	
Do you know the procedure for dental stem cell banking after extraction?	a) Yes	46 (33.6)	66 (56.9)	24 (50)	0.001	24 (27.30)	49 (41.50)	22 (47.80)	48 (30.40)	0.025
	b) No	91 (66.4)	50 (43.1)	24 (50)		64 (72.70)	69 (58.50)	24 (52.20)	110 (69.60)	
Are there any ethical concerns regarding use of stem cells in dentistry?	a) Yes	73 (53.3)	48 (41.4)	38 (79.2)	<0.001	46 (52.30)	68 (57.60)	24 (52.20)	82 (51.90)	0.201
	b) No	8(5.8)	22(19)	0(0)		6(6.80)	2(1.70)	6(13.0)	12(7.60)	
	c) Not aware	56 (40.9)	46 (39.7)	10 (20.8)		36 (40.90)	48 (40.70)	16 (34.80)	64 (40.50)	
The ethical guidelines related to dental stem cells are given by?	a) Indian Council of Medical Research	34 (24.8)	32 (27.6)	32 (66.7)	<0.001	22 (25.0)	30 (25.40)	18 (39.10)	44 (27.80)	0.001
	b) Dental Council of India	12 (8.8)	10 (8.6)	2 (4.2)		10 (11.40)	20 (16.90)	8 (17.40)	54 (34.20)	
	c) Medical Council of India	6 (4.4)	16 (13.8)	0 (0)		2 (2.30)	4 (3.40)	2 (4.30)	2 (1.30)	
	d) None of the Above	6 (4.4)	8 (6.9)	0 (0)		4 (4.50)	6 (5.10)	2 (4.30)	2 (1.30)	
	e) Not aware about it	79 (57.7)	50 (43.1)	14 (29.2)		50 (56.80)	58 (49.20)	16 (34.80)	56 (35.40)	
How long can you preserve dental stem cells?	a) Life long	36 (26.3)	20 (17.2)	20 (41.7)	<0.001	28 (31.80)	32 (27.10)	16 (34.80)	42 (26.60)	<0.001
	b) 10 years	4 (2.9)	26 (22.4)	0 (0)		14 (15.90)	8 (6.80)	6 (13.0)	8 (5.10)	
	c) 20 years	16 (11.7)	18 (15.5)	10 (20.8)		8 (9.10)	15 (12.70)	12 (26.10)	12 (7.60)	
	d) Not aware about it	81 (59.1)	52 (44.8)	18 (37.5)		38 (43.20)	63 (53.40)	12 (26.10)	96 (60.80)	

[Table/Fig-2]: Association of years of experience and year of study to knowledge regarding dental stem cells and tooth banking.

PG: Postgraduate

Questions	Categories	Experience			p-value	Year of study (For students)				p-value
		<5 years n=137 n (%)	5-10 years n=116 n (%)	>10 years n=48 n (%)		1 <sup>st</sup> year PG n=88 n (%)	2 <sup>nd</sup> year PG n=118 n (%)	3 <sup>rd</sup> year PG n=46 n (%)	Intern n=158 n (%)	
		If given a chance, would you like to attempt Regenerative Dentistry based on dental stem cells in your clinical practice?	a) Yes	125 (91.2)		98 (84.5)	38 (79.2)	0.07	82 (93.20)	
b) No	12 (8.8)	18 (15.5)	10 (20.8)	6 (6.80)	16 (13.60)	4 (8.70)	14 (8.90)			

Is preservation of dental stem cells important, even after preservation of umbilical cord stem cells?	a) Yes	97 (70.8)	68 (58.6)	42 (87.5)	<0.001	50 (56.80)	84 (71.20)	28 (60.90)	94 (59.50)	0.044
	b) No	4 (2.9)	32 (27.6)	2 (4.2)		8 (9.10)	8 (6.80)	2 (4.30)	4 (2.50)	
	c) Not aware	36 (26.3)	16 (13.8)	4 (8.3)		30 (34.10)	26 (22.0)	16 (34.80)	60 (38.0)	
Will you advise preservation or storage of dental stem cells?	a) Yes	129 (94.2)	100 (86.2)	40 (83.3)	0.041	76 (86.40)	110 (93.20)	36 (78.30)	144 (91.10)	0.028
	b) No	8 (5.8)	16 (13.8)	8 (16.7)		12 (13.60)	8 (6.80)	10 (21.70)	14 (8.90)	

**[Table/Fig-3]:** Association of years of experience and year of study to attitude regarding dental stem cells and tooth banking.

PG: Postgraduate

Questions	Categories	Experience			p-value	Year of study (For students)				p-value
		<5 years n=137 n (%)	5-10 years n=116 n (%)	>10 years n=48 n (%)		1 <sup>st</sup> year PG	2 <sup>nd</sup> year PG	3 <sup>rd</sup> year PG	Intern	
		n=88 n (%)	n=118 n (%)	n=46 n (%)		n=88 n (%)	n=118 n (%)	n=46 n (%)	n=158 n (%)	
Are you willing to collect and invest in dental stem cells for preservation?	a) Yes	109 (79.6)	80 (69)	34 (70.8)	0.136	76 (86.40)	94 (79.70)	38 (82.60)	134 (84.80)	0.573
	b) No	28 (20.4)	36 (31)	14 (29.2)		12 (13.60)	24 (20.30)	8 (17.40)	24 (15.20)	
What do you think are the obstacles for dental professionals in advising dental stem cell therapy?	a) High cost	18 (13.1)	8 (6.9)	2 (4.2)	0.014	2 (2.30)	6 (5.10)	2 (4.30)	18 (11.40)	0.004
	b) Lack of awareness	10 (7.3)	10 (8.6)	6 (12.5)		8 (9.10)	6 (5.10)	6 (13.0)	20 (12.70)	
	c) Ethical issues	4 (2.9)	14 (12.1)	2 (4.2)		2 (2.30)	7 (5.90)	4 (8.70)	4 (2.50)	
	d) Insufficient knowledge among dental practitioners	22 (16.1)	24 (20.7)	4 (8.3)		12 (13.60)	26 (22.0)	6 (13.0)	12 (7.60)	
	e) All of the above	83 (60.6)	60 (51.7)	34 (70.8)		64 (72.70)	73 (61.90)	28 (60.90)	104 (65.80)	
What do you think are the obstacles for patients in obtaining dental stem cell therapy?	a) High cost	12 (8.8)	14 (12.1)	4 (8.3)	<0.001	4 (4.50)	8 (6.80)	4 (8.70)	24 (15.20)	0.001
	b) Lack of awareness	95 (69.3)	48 (41.4)	34 (70.8)		4 (4.50)	9 (7.60)	6 (13.0)	30 (19.0)	
	c) Ethical issues	16 (11.7)	24 (20.7)	2 (4.2)		2 (2.30)	4 (3.40)	0 (0)	0 (0)	
	d) Insufficient awareness among people	0 (0)	12 (10.3)	0 (0)		10 (11.40)	12 (10.20)	4 (8.70)	6 (3.80)	
	e) All of the above	14 (10.2)	18 (15.5)	8 (16.7)		68 (77.30)	83 (70.30)	32 (69.90)	94 (59.50)	
What according to you are the ways to increase awareness of Dental Stem Cells and its preservation?	a) Seminars	6 (4.4)	6 (5.2)	0 (0)	<0.001	2 (2.30)	2 (1.70)	4 (8.70)	20 (12.70)	0.002
	b) Journals	0 (0)	2 (1.7)	0 (0)		0 (0)	2 (1.70)	2 (4.30)	4 (2.50)	
	c) Conferences and CDE programs	0 (0)	12 (10.3)	2 (4.2)		2 (2.30)	2 (1.70)	2 (4.30)	14 (8.90)	
	d) Inclusion in Academic curriculum in Dental Schools	8 (5.8)	20 (17.2)	6 (12.5)		4 (4.50)	10 (8.50)	2 (4.30)	4 (2.50)	
	e) Advertisements and public notice	8 (5.8)	12 (10.3)	4 (8.3)		4 (4.50)	7 (5.90)	2 (4.30)	10 (6.30)	
	f) All of the above	115 (83.9)	64 (55.2)	36 (75)		76 (86.40)	95 (80.50)	34 (73.90)	106 (67.10)	
In future, would you be interested in attending any workshop/conference/ seminar or continuing dental education program about the applications of Dental Stem Cells and Tooth bank?	a) Yes	123 (89.8)	98 (84.5)	46 (95.8)	0.097	80 (90.90)	112 (94.90)	44 (95.70)	144 (91.10)	0.488
	b) No	14 (10.2)	18 (15.5)	2 (4.2)		8 (9.10)	6 (5.10)	2 (4.30)	14 (8.90)	

**[Table/Fig-4]:** Association of years of experience and year of study to practice regarding dental stem cells and tooth banking.

PG: Postgraduate

## DISCUSSION

Stem cells are boon to healthcare sector as it has ability to regenerate deficiency [12]. Therefore, this study targeted to evaluate knowledge and awareness about dental stem cells among dental professionals.

Dental stem cells include dental pulp stem cells, exfoliated deciduous tooth stem cells, and apical papilla stem cells [7]. Dental stem cells can be utilised for regeneration of whole tooth, pulp, dentin and periodontium. Regenerative dentistry is based on the idea of using stem cells, gene therapy, and other regeneration techniques [9]. Dental stem cells are diverse in nature, with applications in the treatment of heart disease, brain tissue, muscular dystrophy, and bone regeneration [12]. Stem cells bank preserving dental stem cells for maximum 20 years are, Stemade Biotech, Transcell Biologics Pvt. Ltd., and Ree Labs [13]. Stem cell therapy is itself under research and also has ethical concerns. For its application in the realm of medicine, researchers must follow the ethical norms set forth by the Indian Council of Medical Research [14]. It can be

breakthrough in field of health for which willingness to collect and invest is important. Lack of awareness, high cost, ethical concerns, etc. are obstacles for both patient and doctor [12].

Storage of dental stem cells is important as they are safest to procure and are multipotent [7]. Davies OG and Scheven BA have given the importance of storing protocol and storage of dental stem cells as biological insurance, which can be utilised for same genetic makeup [10].

Participants of all group had lack of knowledge regarding technique of preservation of dental stem cells and ethical guidelines for its clinical application given by Indian Council of Medical Research. Results found by Nagraj A and Acharya S [13], Katage F et al., [14], Chitroda PK et al., [15] were similar to the present study.

In the present study, it was found that all dental health professionals had positive attitude regarding recommending dental stem cell preservation and tooth banking. Similar result was found by Goswami M et al., [16].

S. No.	Author's name and year	Place of study	Number of subjects	Parameters assessed	Conclusion
1.	Sede MA et al., 2013 [12]	Benin-City, Nigeria	200	Awareness, attitude and knowledge of the use of stem cells in dentistry among Nigerian dentists	High level of awareness, positive attitude and poor knowledge of the use of stem cells in dentistry among a cross section of Nigerian Dentists. Use of stem cells in dentistry is acceptable to Nigerian Dentists.
2.	Nagraj A and Acharya S, 2013 [13]	Jaipur, India	100	Knowledge, awareness and attitude of postgraduate students and dental scientists	Participants were optimistic regarding future prospect of stem cells application in field of dentistry in future. An impending need was felt amongst participants for professional training and additional academic courses on dental stem cell technology.
3.	Chitroda PK et al., 2017 [15]	Karnataka, India	189	Awareness of stem cells among the dental professionals	Good level of awareness among the dental professionals. MDS staff was completely aware of the terminology followed by PG students, BDS staff, and interns. Knowledge can be increased at UG level by conducting seminars, organising seminars and conferences.
4.	Katage F et al., 2017 [14]	Navi Mumbai, India	823	Knowledge, awareness and attitude regarding dental stem cells of Indian dentists	Good awareness regarding stem cells. The awareness, knowledge regarding sources, applications, uses, and clinical research guidelines regarding DSCs are lacking among the dentists. Relatively, higher awareness was seen among the postgraduates probably due to updated and research-oriented curriculum. A positive attitude toward updating the knowledge regarding DSCs.
5.	Alhadlaq A et al., 2019 [17]	Riyadh, Saudi Arabia	606	Knowledge and attitude of recently graduated dentists	There was moderate to positive attitude toward stem cells and their therapeutic applications in dentistry. Knowledge was inadequate.
6.	Goswami M et al., 2020 [16]	New Delhi, India	100	Awareness, knowledge and attitude among dental professionals	High level of awareness about dental stem cells and its applications was noted. A significant association of age and type of practice with awareness of dental stem cells and knowledge regarding their use in developing non-dental tissues was observed. Positive attitude towards recommending dental stem cell banking was seen.
7.	Present study, 2022	Vadodara, India	711	Knowledge, attitude and practice regarding dental stem cells and tooth banking among dental professionals	There is awareness among dental professionals but, there is lack of knowledge on method of collection, ethical concerns and guidelines regarding dental stem cells. There are many obstacles like high cost, patient acceptance, ethical issues and insufficient knowledge among patients and professionals. The dental curriculum and educational programs should include in detail regarding dental stem cells, storage technique and time.

**[Table/Fig-5]:** Comparison of results from around the globe [12-17].

DSC: Dental stem cells; MD: Masters of dental surgery; BDS: Bachelor of dental surgery; PG: Postgraduate

Chitroda PK et al., [15] and Katage F et al., [14] suggested that high cost and lack of awareness are the major factors creating barrier for use of dental stem cells which was similar to our study. Contrary result was found by Nagraj A and Acharya S, [13], in which they suggested that high cost lesser responsible than lack of knowledge for creating barrier in use of dental stem cells.

Chitroda PK et al., [15] found that main obstacles in seeking dental stem cell therapy are high cost, lack of awareness, ethical issue and insufficient knowledge regarding dental stem cells among dental health professional and people similar to our study. Similar result was found by Katage F et al., [14] that high cost and lack of awareness are barriers for recommending dental stem cell therapy by dental professionals.

To gain knowledge there are many methods like seminars, lectures, conferences, workshops, etc. Integrating all these approaches raises public awareness of the subject, bridging the knowledge gap between experts and dental stem cells. Similar studies were found by Chitroda PK et al., [15], Sede MA et al., [12] and Nagraj A and Acharya S [13]. Alhadlaq A et al., [17] concluded that dental curriculum should be updated by adding stem cells and their future applications in dentistry.

All participants showed willingness towards attending future conferences on this topic. Chitroda PK et al., [15] had found that participants are willing to get exposed to such less talked topics like dental stem cells and tooth banking, which is similar to our study. Tabulation of the results of similar studies have been done in [Table/Fig-5] [12-17].

### Limitation(s)

The collected data was self-reported by participants through a questionnaire. Usually, self-reported data cannot be independently verified and may be prone to bias such as exaggerated or lessened response by individuals. Therefore, further assessment and efforts should be undertaken on multicentric level for reducing such bias.

## CONCLUSION(S)

This study suggests that there was awareness among dental professionals regarding dental stem cells but still, there was lack of knowledge on method of collection, ethical concerns and guidelines regarding dental stem cells. It was found that there are many obstacles like high cost, patient acceptance, ethical issues and insufficient knowledge among patients and professionals. There is need for increasing horizon of dental stem cells and making professionals skilled and patients aware about it so that these can be used for regeneration. The dental curriculum and educational programs should include in detail regarding dental stem cells, storage technique and time. Therefore, it will open new ways for dental stem cell therapy in the field of dentistry. There is need for future in-vivo research and increase applicability of dental stem cells in treatment in field of dentistry.

## REFERENCES

- [1] Krafts KP. Tissue repair: The hidden drama. *Organogenesis*. 2010;6(4):225-33. Doi: 10.4161/org.6.4.12555. PMID: 21220961; PMCID: PMC3055648.
- [2] Isobe Y, Koyama N, Nakao K, Osawa K, Ikeno M, Yamanaka S, et al. Comparison of human mesenchymal stem cells derived from bone marrow, synovial fluid, adult dental pulp, and exfoliated deciduous tooth pulp. *Int J Oral Maxillofac Surg*. 2016;45(1):124-31. Doi: 10.1016/j.ijom.2015.06.022. Epub 2015 Jul 30. PMID: 26235629.
- [3] Hemalatha R, Panneerselvam K. Dental stem cells origin, banking, engineering and applications. *J Appl Dent Med Sci*. 2017;3:3.
- [4] Hynes K, Menicanin D, Gronthos S, Bartold PM. Clinical utility of stem cells for periodontal regeneration. *Periodontol* 2000. 2012;59(1):203-27. Doi: 10.1111/j.1600-0757.2012.00443.x. PMID: 22507067.
- [5] Estrela C, Alencar AH, Kitten GT, Vencio EF, Gava E. Mesenchymal stem cells in the dental tissues: Perspectives for tissue regeneration. *Braz Dent J*. 2011;22(2):91-98. Doi: 10.1590/s0103-64402011000200001. PMID: 21537580.
- [6] Gronthos S, Mankani M, Brahimi J, Robey PG, Shi S. Postnatal human dental pulp stem cells (DPSCs) in vitro and in vivo. *Proc Natl Acad Sci U S A*. 2000;97(25):13625-30. Doi: 10.1073/pnas.240309797. PMID: 11087820; PMCID: PMC17626.
- [7] Kerkis I, Caplan AL. Stem cells in dental pulp of deciduous teeth. *Tissue Eng Part B Rev*. 2012;18(2):129-38. Doi: 10.1089/ten.TEB.2011.0327. Epub 2011 Dec 28. PMID: 22032258; PMCID: PMC3311402.
- [8] Huang YH, Yang JC, Wang CW, Lee SY. Dental stem cells and tooth banking for regenerative medicine. *J Exp Clin Med*. 2010;2(3):111-17.

- [9] Miura M, Gronthos S, Zhao M, Lu B, Fisher LW, Robey PG, et al. SHED: Stem cells from human exfoliated deciduous teeth. *Proc Natl Acad Sci U S A*. 2003;100(10):5807-12. Doi: 10.1073/pnas.0937635100. Epub 2003 Apr 25. PMID: 12716973; PMCID: PMC156282.
- [10] Davies OG, Scheven BA. Isolation and cryopreservation of stem cells from Dental tissues. *Dental Stem Cells: Regenerative Potential*. 2016:57-71
- [11] Bajaj N, Grewal N, Monga P, Grewal S. Association of physical properties and maintenance of sterility of primary teeth in human tooth bank. *J Indian Soc Pedod Prev Dent*. 2014;32(4):279-85. Doi: 10.4103/0970-4388.140939. PMID: 25231034.
- [12] Sede MA, Audu O, Azodo CC, Sede MA, Audu O, Azodo CC, et al. Stem cells in dentistry: Knowledge and attitude of Nigerian dentists. *BMC Oral Health*. 2013;13:27. Doi: 10.1186/1472-6831-13-27. PMID: 23767980; PMCID: PMC3686702.
- [13] Nagraj A, Acharya S. Perception of dental scientists and post-graduate students regarding future prospects of stem cells in dentistry. *Acta Stomatol Croat*. 2013;47(4):312-21.
- [14] Katge F, Shetty AJ, Rusawat B, Vamsi KC. Knowledge and attitude of Indian dentists regarding dental stem cells: A cross-sectional descriptive survey. *Indian J Dent Res*. 2017;28(4):367-374. Doi: 10.4103/ijdr.IJDR\_389\_16. PMID: 28836526.
- [15] Chitroda PK, Katti G, Attar NM, Shahbaz S, Sreenivasarao G, Patil A, et al. Stem cells in dentistry: A study regarding awareness of stem cells among dental professionals. *Indian J Dent Res*. 2017;28(6):711-16. Doi: 10.4103/ijdr.IJDR\_771\_16. PMID: 29256476.
- [16] Goswami M, Kumar G, Sharma S. "Dental stem cells": Awareness, knowledge, and attitude of dental professionals-A cross-sectional study. *Spec Care Dentist*. 2020;40(1):90-96. Doi: 10.1111/scd.12442. Epub 2019 Dec 9. PMID: 31815303.
- [17] Alhadlaq A, Al-Maflehi N, Alzahrani S, AlAssiri A. Assessment of knowledge and attitude toward stem cells and their implications in dentistry among recent graduates of dental schools in Saudi Arabia. *Saudi Dent J*. 2019;31(1):66-75. Doi: 10.1016/j.sdentj.2018.10.006. Epub 2018 Nov 10. PMID: 30705571; PMCID: PMC6349953.

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## ANNEXURE 1

### Questionnaire

Title: "Knowledge Attitude and Practice Regarding Dental Stem Cells and Tooth Banking Among Dental Professionals: A Questionnaire Based Cross-sectional Study"

#### Consent

**1. I confirm that I have read and understood the information sheet.**

a) Yes b) No

**2. I agree to take part in the study.**

a) Yes b) No

#### 3. General information

1. Name :

2. Age :

3. Gender : Male/Female/Others

#### 4. Qualification:

a) BDS b) MDS

**5. Specialty:** \_\_\_\_\_

#### 6. Working as:

a) Student:

b) Faculty:

c) Practitioner:

d) Practitioner and Faculty Both:

**7. Name of Institute/Clinic:** \_\_\_\_\_

**8. City:** \_\_\_\_\_

#### 9. Experience since Start of Practice (Faculty/Practitioners)

a) Less than 5:

b) 5-10:

c) More than 10:

#### 10. Year of Study (For Students)

Intern    1<sup>st</sup> year postgraduate    2<sup>nd</sup> year postgraduate  
3<sup>rd</sup> year postgraduate

#### Questionnaire

1. Are you aware of the concept of dental stem cells?

a) Yes b) No

2. What are different types of dental stem cells?

a) Dental pulp stem cells

b) Stem cells from shaded human milk teeth

c) Stem cells from apical papilla/Stem cells from tissue beneath the tooth

d) All of the above

e) Not aware about it

3. Are you aware of various applications of dental stem cells?

a) Yes b) No

4. What are different applications of dental stem cells?

a) Whole tooth regeneration

b) Periodontal ligament, cementum, alveolar bone/tooth supporting structures regeneration

c) Regeneration of pulp/dentin

d) All of the above

e) Not aware about it

5. Are you aware of concept of Regenerative Dentistry based on dental stem cells?

a) Yes b) No

6. If given a chance, would you like to attempt Regenerative Dentistry based on dental stem cells in your clinical practice?

a) Yes b) No

7. Is preservation of dental stem cells important, even after preservation of umbilical cord stem cells?
- Yes
  - No
  - Not aware about it
8. Can dental stem cells be used to develop non dental tissue?
- Yes
  - No
  - Not aware about it
9. What are non dental applications of dental stem cells?
- Heart therapies
  - Brain tissue regeneration
  - Muscular dystrophy therapies
  - Bone regeneration
  - All of the above
  - None of the above
10. Are you aware of dental stem cell banks in India?
- Yes
  - No
11. Which of the following are names of various stem cell banks in India?
- Stemade Biotech
  - Transcell Biologics Pvt. Ltd.
  - Ree Labs
  - All of the above
  - None of the above
12. Do you know the procedure for dental stem cell banking after extraction?
- Yes
  - No
13. Are there any ethical concerns regarding use of stem cells in dentistry?
- Yes
  - No
  - Not aware about it
14. The ethical guidelines related to dental stem cells is given by?
- Indian Council of Medical Research
  - Dental Council of India
  - Medical Council of India
  - None of the Above
  - Not aware about it
15. How long can you preserve dental stem cells?
- Life long
  - 10 years
  - 20 years
  - Not aware about it
16. Will you advise preservation or storage of dental stem cells?
- Yes
  - No
17. Are you willing to collect and invest in dental stem cells for preservation?
- Yes
  - No
18. What do you think are the obstacles for dental professionals in advising dental stem cell therapy?
- High cost
  - Lack of awareness
  - Ethical issues
  - Insufficient knowledge among dental practitioners
  - All of the above
19. What do you think are the obstacles for patients in obtaining dental stem cell therapy?
- High cost
  - Lack of awareness
  - Ethical issues
  - Insufficient awareness among people
  - All of the above
20. What according to you are the ways to increase awareness of dental stem cells and its preservation?
- Seminars
  - Journals
  - Conferences and CDE programs
  - Inclusion in Academic curriculum in Dental Schools
  - Advertisements and public notice
  - All of the above
21. In future, would you be interested in attending any workshop/conference/seminar or continuing dental education program about the applications of dental stem cells and tooth bank?
- Yes
  - No