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Original Research Article

Evaluation of Dentists' Awareness, Knowledge, and Attitude towards Dental Stem Cells

Diş Hekimlerinin Dental Kök Hücrelere Dair Bilgi, Farkındalık ve Tutumlarının Değerlendirilmesi

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ABSTRACT

Aim: Various adult stem cell populations exist in dental tissues. These are known as dental stem cells. Dentists play an active role in the collection, preservation, and inclusion of dental stem cells into treatment processes. This study aimed to evaluate dentists' awareness regarding dental stem cells as well as their knowledge and attitudes towards dental stem cells. The study included dentists with different professional experience.

Materials and Method: In this study, a total sample size consisting of 112 dentists working in different sectors in Ankara province in May-June 2023 and having different professional experience periods was selected. A hand-delivered questionnaire consisting of 22 items was used to evaluate dentists' awareness, knowledge, and attitude toward dental stem cells. The results were statistically analyzed by using the chi-squared test.

Results: 96.4% of the participants had knowledge about stem cells, while 82.1% had knowledge about dental stem cells. 11.6% of those who had knowledge about dental stem cells found their knowledge sufficient. 58% of the participants had knowledge that there were stem cell banks in Turkey. 83.7% of those with <5 years of professional experience, 85.4% of those with 5-15 years of professional experience and 72.7% of those with >15 years of professional experience had awareness regarding dental stem cells (p=0.428). The rate of awareness towards stem cell banks was significantly lower in those with <5 years of professional experience (p=0.016).

Conclusion: This study reveals that dentists have a high awareness of dental stem cells but do not have sufficient knowledge about their basic features. Dentists need knowledge content that starts with undergraduate education about dental stem cell sources and stem cell banks and continues with postgraduate education programs.

Keywords: Knowledge; Dentistry; Awareness; Stem cell

ÖZET

Amaç: Diş dokularında çeşitli yetişkin kök hücre popülasyonları bulunur ve bunlar dental kök hücreler olarak bilinir. Dental kök hücrelerin toplanması, saklanması ve tedaviye dahil edilmesi aşamalarında diş hekimleri aktif rol almaktadır. Bu çalışmada, farklı mesleki deneyime sahip diş hekimleri arasında dental kök hücrelerin varlığına ilişkin farkındalığın ve dental kök hücrelere ilişkin bilgi ve tutumlarının değerlendirilmesi amaçlanmıştır.

Gereç ve Yöntemler: Bu çalışmada Mayıs-Haziran 2023 tarihinde Ankara ilinde farklı sektörlerde çalışan ve farklı mesleki deneyim sürelerine sahip 112 diş hekiminden oluşan toplam örneklem büyüklüğü seçildi. Diş hekimlerinin dental kök hücrelerine yönelik farkındalığını, bilgisini ve tutumunu değerlendirmek için elden teslim edilen, 22 soruluk bir anket kullanıldı. Sonuçlar ki-kare testi kullanılarak istatistiksel olarak analiz edildi.

Bulgular: Katılımcıların %96.4'ünün kök hücreler, %82.1'inin dental kök hücreler hakkında bilgisi vardı. Dental kök hücreler hakkında bilgi sahibi olanların %11.6'sı bilgi birikimini yeterli buluyordu. Katılımcıların %58'i Türkiye'de kök hücre bankalarının olduğunu biliyordu. Mesleki deneyimi <5 yıl olanların %83.7'si, 5-15 yıl olanların %85.4'ü ve >15 yıl olanların %72.7'si dental kök hücrelerin farkındaydı (p=0.428). Mesleki deneyimi <5 yıl olanların kök hücre bankalarından haberdar olma oranı anlamlı olarak daha düşüktü (p=0.016).

Sonuç: Bu çalışma diş hekimlerinin dental kök hücreler hakkında yüksek farkındalığa sahip oldukları ancak temel özellikleri hakkında yeterli bilgiye sahip olmadıklarını göstermektedir. Dental kök hücre kaynakları ve kök hücre bankaları hakkında lisans eğitimiyle başlayan ve mezuniyet sonrası eğitim programlarıyla devam eden bilgi içeriklerine diş hekimlerinin ihtiyacı vardır.

Anahtar Kelimeler: Bilgi; Diş hekimliği; Farkındalık; Kök hücre

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INTRODUCTION

Stem cells are precursor progenitor cells with the potential to evolve into specialized cell types.[1] Various populations of adult stem cells exist in dental tissues, and these are known as dental stem cells (DSC).[2] According to their origins, DSCs are classified as dental pulp stem cells, stem cells from human exfoliated deciduous teeth, periodontal ligament stem cells, gingival-derived stem cells, stem cells from the apical papilla and tooth germ progenitor cells derived from third molars.[3]

DSCs are adult stem cell types with very high tissue regeneration capacity. The most important advantage of DSC is that it is easily obtainable.[4] Another advantage of cord blood compared to stem cell applications is that it can be obtained more than once during the individual's life. It is also relatively more noninvasive and painless than bone marrow stem cell applications.[4,5]

DSCs are of ectomesenchymal origin and have the potential to regenerate dentin, pulp, periodontal ligament and cement as well as to differentiate into adipocytes, nerve cells, osteocytes, chondrocytes and myocytes.[4,5] In the near future, DSC will contribute to the emergence of new treatment approaches that will help repair defects in all dental tissues through strategies developed by dentists and tissue engineers. In addition to dental structures, the regenerative capacities of DSCs are tried to be utilized on orofacial structures such as salivary glands, tongue, maxillofacial muscle structures and temporomandibular joint components.[6] In addition to dental practices, DSCs have begun to be investigated in various fields in medicine. For example, studies are using DSC in the treatment of motor neuron damage, liver diseases, and some neurodegenerative disorders (such as Alzheimer's).[4,7]

Dentists' awareness, knowledge, and attitude toward DSC is a relatively unexplored field and should be evaluated to obtain basic information on the subject. Providing knowledge and spreading awareness regarding DSC among dentists may benefit the creation of programs on the subject in the future and its delivery to a wider audience. Therefore, this study aimed to evaluate the awareness, knowledge and attitude of dentists with different professional experience towards DSC.

MATERIALS AND METHOD

Study Design

This is a cross-sectional and questionnaire-based study. The study included a total of 112 dentists.

Sampling and Participants

Dentists, who had different professional experience periods and worked in the Oral and Dental Health Application and Research Centers of the Ministry of Health in Ankara, private clinics and dentistry faculties of universities, were invited to participate in the study between May and June 2023. Dentistry students, retired dentists, and dentists, who did not answer all of the questions, were excluded from the study.

Data Collection

The study was carried out by using a self-administered, hand-delivered, and 22-item questionnaire that collected data on dentists' awareness, knowledge and attitude towards DSC. The questionnaire was developed based on similar studies in the literature on DSC.[4,8] Through the questionnaire, information about demographic variables such as age, gender, years of experience, field of expertise and workplace were obtained. The questionnaire consisted of items aiming to evaluate awareness regarding the presence of DSC, awareness of the presence of stem cell banks in Turkey, recent developments about stem cells, sources of information on the subject, basic level of knowledge about DSC and areas of use in dental treatments.

Data Analysis

After the items were answered, the collected data were transferred to the computer environment, and the answers given by the participants to each question were shown in the tables with their percentages. The answers to some items were presented in bar charts.

Statistical Analysis

Statistical analysis was completed by transferring the data to IBM SPSS Statistics 26 program. As a result of the power analysis applied with the GPower 3.1.9.7 program, the sample size was determined as 84 people according to the value of type 1 er-

ror: 0.05, type 2 error: 0.20 and effect size = 0.30 to determine the relationship between the measurements. While evaluating the study data, descriptive statistics (mean, standard deviation) are given for numerical variables and (number, percentage) for categorical variables. Differences between groups were examined using One-way ANOVA/independent sample t-test or Kruskal Wallis test/Mann Whitney U test, depending on suitability for normal distribution. For the relationship between measurements, Pearson or Spearman correlation analysis was used, depending on suitability for normal distribution. $p<0.05$ was accepted for significance.

Ethical Approval

This study was approved by Gazi University Faculty of Dentistry Clinical Researches Ethics Committee. (Decision date: 28/12/2023, Approval no.: 2023 – 503)

Informed Consent

Prior to the questionnaire, each participant was informed about the study procedure and objective, and an informed consent form was obtained from each participant. No incentive was offered for completing the questionnaire.

RESULTS

112 dentists were included in this study. 47.3% (n: 53) of the participants were male, and 52.7% (n: 59) were female. The rate of those with less than 5 years of professional experience was 43.75% (n: 49), while the rate of those with more than 15 years of professional experience was 19.6% (n: 22). 71.4% (n: 80) of the participants worked in private clinics, and 26.78% (n: 30) in the dentistry faculties of universities. The rate of those, who received specialty training in any branch of dentistry, was 26.8% (n: 30).

91.1% (n: 102) of the participants had heard of stem cells before, and 82.1% (n: 92) had heard of DSC before. The rate of those, who considered their level of knowledge about DSC sufficient was 11.6% (n: 13), while the rate of those who consider the opposite was 74.1% (n: 83). 58.04% (n: 65) of the participants knew that there were stem cell banks in Turkey. The rate of the participants, who thought that DSC was an important branch open to development in dentistry, was 60.7% (n: 68).

The answers given to the question from which source the information about DSC was obtained were shown in Figure 1, and the answers given to the questions asking basic information about dental stem cells and their application in dental treatments were shown in Table 1. Opinions regarding the obstacles in the practice of DSC treatments were schematized in Figure 2. The data regarding the requests and suggestions for information about DSC were listed in Table 2.

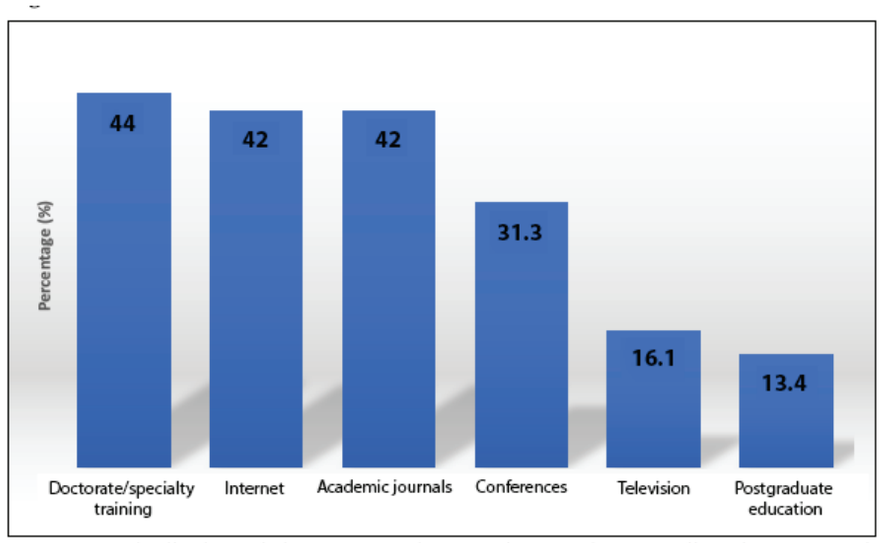

Figure 1. Distribution of the answers given to the question regarding the source of the information on dental stem cells

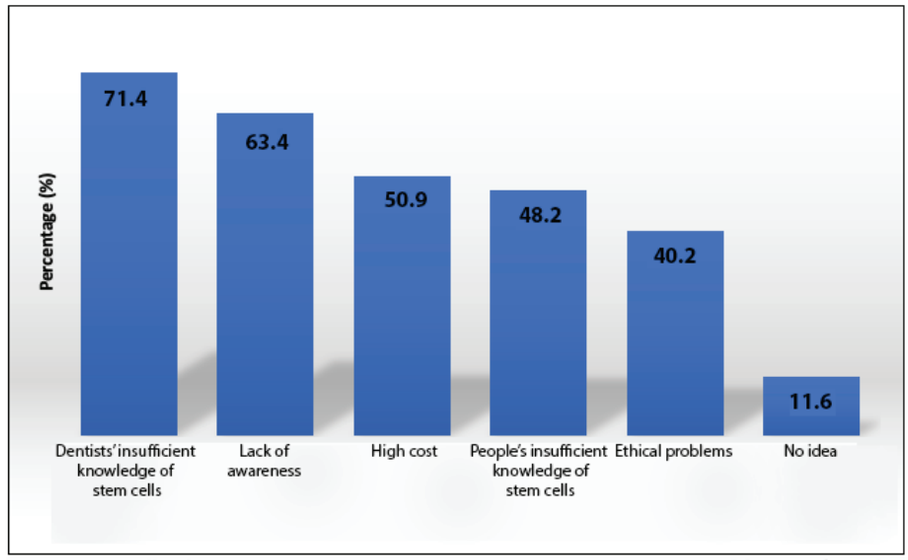

Figure 2. Distribution of the answers given to the question regarding the biggest obstacle to the application of dental stem cell treatments

Table 1. Distribution of answers to questions asking basic information about dental stem cells and their application in dental treatments

In which classification are dental stem cells included?	**n (%)**
Adult stem cells	57 (50.9%)
Embryonic stem cells	27 (24.1%)
No idea	28 (25.0%)
Do dental stem cells have the ability to regenerate in body tissues other than dental tissues?	**n (%)**
Yes	25 (22.3%)
No	18 (16.1%)
No idea	69 (61.6%)
Which of the following(s) can dental stem cells be obtained?	**n (%)**
Deciduous tooth pulp	88 (76.6%)
Dental pulp	48 (42.9%)
Periodontal ligament	39 (34.9%)
Wisdom tooth	50 (44.6%)
Apical papilla	30 (26.8%)
No idea	13 (11.6%)
Can a complete tooth be obtained from dental stem cell?	**n (%)**
Yes	40 (35.7%)
No	21 (18.8%)
No idea	51 (45.5%)
Can dental stem cells be applied in trauma treatments?	**n (%)**
Yes	77 (68.8%)
No	6 (5.4%)
No idea	29 (25.9%)
Can dental stem cells be used in cleft palate treatment?	**n (%)**
Yes	43 (38.4%)
No	0 (0.0%)
No idea	69 (61.6%)
What are the different clinical applications of dental stem cells for oral health?	**n (%)**
Dentin/pulp regeneration	55 (49.1%)
Alveolar bone regeneration	44 (39.3%)
Periodontal ligament regeneration	30 (26.8%)
No idea	33 (29.5%)

Table 2. Data on requests and suggestions for obtaining information about dental stem cells

Would you like to know more about dental stem cells?	**n (%)**
Yes	103 (92.0%)
No	9 (8.0%)
Have you ever attended any seminar/conference on stem cells?	**n (%)**
Yes	36 (32.1%)
No	76 (67.9%)
Would you like if there are more seminars/conferences on dental stem cells?	**n (%)**
Yes	96 (85.7%)
No	16 (14.3%)
Do you think dental stem cells should be included in the dental curriculum?	**n (%)**
Yes	108 (96.4%)
No	4 (3.6%)

87.8% of those with less than 5 years of professional experience, 85.4% of those with 5-15 years of professional experience and 95.5% of those with more than 15 years of professional experience were aware of DSCs (p=0.519). 42.9% of those with less than 5 years of professional experience, 70.7% of those with 5-15 years of professional experience and 68.2% of those with more than 15 years of professional experience knew that there were stem cell banks in Turkey. Those with less than 5 years of professional experience were significantly less aware of stem cell banks (p=0.016). The rate of those, who knew that DSC was included in the adult stem cells class, was 53.1% in those with less than 5 years of professional experience, 58.5% in those with 5-15 years of professional experience, and 31.8% in those with more than 15 years of professional experience (p=0.354). The rate of those, who knew that a complete tooth could be derived from DSC, was 24.5% in those with less than 5 years of professional experience, 41.5% in those with 5-15 years of professional experience, and 50.0% in those with more than 15 years of professional experience, and this rate was significantly lower in those with less than 5 years of professional experience (p=0.036). 16.3% of those with less than 5 years of professional experience, 39.0% of those with 5-15 years of professional experience and 4.5% of those with more than 15 years of professional experience knew that DSC had the ability to regenerate body tissues except dental tissues (p=0.001). 81.6% of those with less than 5 years of professional experience, 68.3% of those with 5-15 years of professional experience, and 40.9% of those with more than 15 years of professional experience knew that DSCs were applicable in trauma treatments. The rate of those, who knew that DSC was applicable in trauma treatments, was significantly lower in those with more than 15 years of work experience (p=0.008). The rate of those, who knew that DSC could be used in cleft palate treatment, was 36.7% in those with less than 5 years of professional experience, 51.3% in those with 5-15 years of professional experience, and 18.2% in those with more than 15 years of professional experience, and this rate was significantly lower in those with more than 15 years of professional experience (p=0.035) (Table 3).

There was no significant difference between those with and without specialty training in terms of awareness of DSC (p=0.766). The rate of those, who knew that there was a stem cell bank in Turkey (p= 0.037), the rate of those, who knew that DSC was in the adult stem cell class (p=0.001), the rate of those who knew that DSC could be obtained as a complete tooth (p=0.004), the rate of those, who knew that DSC had the ability to regenerate in body tissues other than dental tissues (p=0.001), the rate of those, who knew that DSC could be applied in trauma treatments, (p=0.001) and the rate of those who knew that DSC could be used in cleft palate treatment (p=0.001) were significantly higher in those with specialty training (Table 4).

Table 3. Comparison of knowledge levels about dental stem cells by years of professional experiences

	<5 years n (%)	5-15 years n (%)	>15 years n (%)	P Value
Aware of dental stem cells	43 (87.8%)	38 (85.4%)	21 (95.5%)	0.519
Knows that there is a stem cell bank in Turkey	21 (42.9%)	29 (70.7%)	15 (68.2%)	0.016
Knows that dental stem cells are included in the class of adult stem cells	26 (53.1%)	24 (58.5%)	7 (31.8%)	0.354
Knows that a complete tooth can be obtained from a dental stem cell	12 (24.5%)	17 (41.5%)	11 (50.0%)	0.036
Knows that dental stem cells can regenerate body tissues other than dental tissues	8 (16.3%)	16 (39.0%)	1 (4.5%)	0.001
Knows that dental stem cells can be applied in trauma treatments	40 (81.6%)	28 (68.3%)	9 (40.9%)	0.008
Knows that dental stem cells can be used in the treatment of cleft palate	18 (36.7%)	21 (51.2%)	4 (18.2%)	0.035

Table 4. Comparison of knowledge levels regarding dental stem cells by specialty training

	Specialty training		P value
	Yes (%)	No (%)	
Aware of dental stem cells	90.2%	91.8%	0.766
Knows that there is a stem cell bank in Turkey	68.6%	49.2%	0.037
Knows that dental stem cells are included in the class of adult stem cells	65.6%	33.3%	0.001
Knows that a complete tooth can be obtained from a dental stem cell	50.8%	39.2%	0.004
Knows that dental stem cells can regenerate body tissues other than dental tissues	80.3%	39.2%	0.001
Knows that dental stem cells can be applied in trauma treatments	39.3%	9.8%	0.001
Knows that dental stem cells can be used in the treatment of cleft palate	82.5%	33.3%	0.001

DISCUSSION

Stem cells are cells that differentiate into different cell types by undergoing a large number of cell divisions and sustain their proliferation characteristics. They are also known as progenitor cells due to their ability to self-renew and differentiate.[1] Stem cells are classified as embryonic and adult stem cells in terms of their differentiation potential and origin. Adult stem cells are postnatal stem cells that can be derived from the bone marrow, umbilical cord, pancreas, adipose tissue and dental pulp.[9]

DSC is an easy-to-access and convenient adult stem cell type. There are various sources of DSC in the mouth, such as the dental pulp, dental follicle, periodontal ligament, alveolar bone marrow and dental germ. These progenitor cells have wide use in dentistry such as regeneration of an immature tooth with extensive pulp damage, periodontal regeneration, biological tooth and stem cell-based treatments.[10]

Stem cell studies around the world are conducted with great speed and hope. Scientists carry out studies to produce treatments that try to repair damaged tissues with tissues grown from stem cells. In dentistry, studies are continuing about the regeneration of damaged periodontal tissue, bone, pulp and dentin. DSC has the potential to regenerate dentin, periodontal ligament and cementum and can also be used to repair bone defects.[11] Undoubtedly, promising and DSC-supported treatment validated with *in vitro* studies need to be carried out with a multidisciplinary approach. Dentists play a critical role in informing patients and managing the treatment process correctly. Playing this role in the most effective way requires to understand the great potential associated with the use of stem cells in the clinical setting and to evaluate their level of knowledge.

In the literature, studies examining the awareness and knowledge level of dentists regarding stem cells and DSC are limited.[1,4,8] Among the dentists partic-

ipating in this study, awareness of both stem cells and DSC was found to be quite high. No statistically significant difference was found between professional experience and awareness of stem cell. In a study conducted by Chitroda *et al*.[1] in India, it was revealed that 95.2% of dentists heard of DSC before; however, only 53.9% were aware of the application areas of DSC. Katge *et al*.[12] concluded that dentists had a good awareness of stem cells, but their level of knowledge towards applications, sources and areas of use for DSC was insufficient. When compared to the results of previous studies, our study revealed that awareness of dentists towards DSC was higher. Similar to these studies, it is seen that dentists have higher stem cell awareness compared to DSC. The differences between studies may be due to different study populations and study periods. DSC is a subject that has come to the forefront recently, and its low awareness in the past is an expected result accordingly.

The effect of experienced dentists on stem cell awareness has been investigated by studies. In the study conducted by Gosvami *et al*.[4], the rate of DSC awareness was higher in dentists aged over 29 and those with more than 5 years of experience. In addition, senior assistants and postgraduate students had a higher awareness rate compared to interns. Similar findings were reported by Sede (2013)[13] and Chitroda (2017)[1], while opposite results were reported by Katge (2017)[12]. In our study, it was concluded that the duration of professional experience did not have a significant effect on the rate of awareness regarding DSC.

Following the publication of the Ministry of Health Cord Blood Banking Regulation dated 5 July 2005, stem cell banks started to be opened in our country. Their number and activities are increasing day by day.[14] Recently, it has been quite popular to store deciduous teeth for future use as a source of stem cells. The use of this stored DSC is not only limited to the donor but can also be used for other family members. These stem cells obtained from deciduous teeth in stem cell banks can be stored for 20-25 years.[15] It is highly important for dentists to be aware of the existence of these stem cell banks and to inform patients and their relatives accordingly. In our study, only 58% of the dentists were aware of the existence of these stem cell banks in our country. In their study, Gosvami *et al*.[4] reported that only 24% of the dentists in India were aware of the stem cell bank in their country. In another study conducted by Goyal[16], 43.7% of the dentists reported that they were aware of the stem cell banks in their countries. In our study, although the rate of dentists' awareness of stem cell banks was high compared to the data in the literature, 58% can be considered low. It is seen that dentists should be informed about the existence of stem cell banks to make DSC treatments more widespread. It is important for dentists not only have comprehensive scientific knowledge through the literature, but also have awareness of the commercial dimensions of stem cell banking.

Stem cell has recently become an increasingly popular issue, and information can be obtained through many different channels. In this study, almost all participants stated that they wanted to know more about DSC, and their preferred source of information about DSC was often specialty training. This was followed by the internet, academic journals, conferences, and television. Similarly, in the literature, it was observed that undergraduate education curriculum, academic journals and the internet were often the source of information for dentists about DSC.[4,12,16,17] These findings show that the dominant learning way of the participants were postgraduate education, conferences, internet, and journals. The high awareness regarding stem cell use in dentistry may be due to the contribution of undergraduate education to awareness on the subject. Therefore, 70% of the participants in our study stated that the subject of DSC should be included in the dentistry curriculum. In parallel with the findings of our study, it is seen that conferences and seminars are good and preferred methods to increase the level of knowledge about DSC and are activities requested by dentists.[12,18] In addition, this study revealed that the awareness of dentists, who received specialty training after graduation, was significantly higher than those who did not receive any specialty training ($p<0.05$). In addition, almost half of the participants reported that they gained their knowledge about DSC during specialty training. When all these results are evaluated together, it is seen that specialty training has an important place for dentists in terms of obtaining dental stem cell knowledge.

In general, questions were asked to the participants to reveal their knowledge level regarding DSC. 25% of the participants reported that DSC was in the class of adult stem cells, 22.3% reported that DSC had regeneration ability in body tissues other than dental tissues, 35.7% reported that a complete tooth could be derived from DSC, 68.8% reported that DSC could be applied in trauma treatments, and 38.4% reported that DSC could be used in cleft palate treatment. When it was examined whether there was a significant relationship between the professional experience of dentists and their level of knowledge regarding DSC, a statistically significant relationship was found between the duration of professional experience and the answers given to the questions that ″there was a stem cell bank in Turkey″, ″a complete tooth can be obtained from DSC″, ″DSC can be used in cleft palate treatment″, ″DSC can be applied in trauma treatments″, and ″DSC has the ability to regenerate body tissues other than dental tissues″ ($p<0.05$).

Among the challenges encountered in stem cell applications are the lack of awareness and knowledge in dentists, high cost and low patient awareness. In our study, it was observed that the biggest obstacles to the DSC treatments were the lack of knowledge of dentists about stem cells, lack of awareness, high cost, insufficient knowledge of patients about stem cells and ethical problems. The findings obtained in studies conducted with similar purposes in the literature are in parallel with our study.[12,16]

It is possible to state that Turkish dentists participating in the study have a high level of awareness about DSC but do not have sufficient knowledge about its basic features. The most important limitation of this study is that it was conducted in a single center. Therefore, additional research from multiple centers is needed to accurately assess the level of knowledge and awareness of Turkish dentists towards DSC and to inform the development of the undergraduate curriculum and the content of the training programs that can be organized after graduation.

CONCLUSIONS

Dentists are expected to have relevant knowledge and a positive approach to stem cell applications so that stem cell treatments can develop and the use of DSC can make progress in dentistry and medicine. In order to raise awareness towards DSC and to direct dentists to the right information, the subject should be comprehensively included in undergraduate and specialty training, and the knowledge should be kept up-to-date with conferences and workshops. In this way, dentists can start treatment with the right guidance at the right time and use the great potential of DSC in the treatment of dental and medical disorders.

CONFLICT OF INTEREST

The authors declare no conflicts of interest.

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