How has Tooth Manipulation been Conducted for Dental Pulp Stem Cells Isolation? A Scoping Review

Camila P Ferrúa, Cainá C do Amaral, Roberta Giorgi, Tiago Garcia, Fernanda Nedel

ABSTRACT

The aim of this study was to realize a scoping review the literature to verify how tooth manipulation for dental pulp stem cells (DPSCs) isolation has been conducted and if a standard tooth preparation protocol for DPSCs isolation exists. The electronic search was conducted without initial date restriction up to and including April 2014 in PubMed, Scopus, Scielo, and ISI Web of Knowledge databases to identify studies that described the methodology used for DPSCs isolation. Two hundred and twenty-two articles were included and the information analysis was performed concerning dental manipulation and pulp tissue processing.

Furthermore, the quality of included studies was evaluated through the assessment of the risk of bias. This scoping review established a platform for dental manipulation protocols for DPSCs isolation purposes. Over the past years, many studies have been conducted using DPSCs. However, there is a clear lack of standardization in tooth manipulation before DPSCs isolation. Currently, given a large number of variables in cell isolation techniques and all possible consequences in the in vitro behavior of cells, it is important to reinforce the importance of standard protocols to obtain a uniform cell culture.

Keywords: Dental pulp, Dental pulp stem cell, Manipulation, Scoping review, Stem cell.

How to cite this article: Ferrúa CP, Amaral CC do, Giorgi R, Garcia T, Nedel F. How has Tooth Manipulation been Conducted for Dental Pulp Stem Cells Isolation? A Scoping Review. Int J Experiment Dent Sci 2018;7(2):98-135.

Source of support: Nil

Conflict of interest: None

INTRODUCTION

Mesenchymal stem cells (MSCs) have been considered a promising treatment alternative for illnesses such as type 1 diabetes and heart disease, among others. Advances in the treatment of these diseases are closely associated with the growing number of stem cell research; however, most studies are developed in animal models, suggesting that more research is needed to translate results to human applications. For this, a cell source easily obtainable, with rapid in vitro expansion and high proliferative rates is mandatory. Among available options with such characteristics are the dental pulp stem cells (DPSCs).

DPSCs are found in small quantities in the human dental pulp. Therefore, the simulation of the cellular microenvironment must be the best possible to achieve a sufficient cell proliferation rate and quality for in vitro or in vivo purposes. However, teeth manipulation and pulp tissue processing for cell isolation is a complex task and can be determinant in the success of stem cell isolation.

Although DPSCs have been widely used in studies with clinical applications, the literature is scarce in relation to tooth preparation before DPSCs isolation. Thus, the aim of this study was to realize a scoping review to verify how tooth manipulation for DPSCs isolation has been conducted and if a standard tooth preparation protocol exists. To the best of our knowledge, this is the first scoping review evaluating tooth manipulation for DPSCs isolation.

MATERIALS AND METHODS

Study Questions

How tooth manipulation for DPSCs isolation has been conducted?

Is there a standardized protocol for tooth manipulation to isolate DPSCs?

Inclusion and Exclusion Criteria

To be included, the study had to describe stem cell isolation from human dental pulp of permanent teeth. Exclusion criteria were studies using cells from a non-human source, stem cells from sources other than the dental pulp, human cells but not stem cells, SHEDs, and studies in which the tooth manipulation and isolation technique were not described. Literature reviews, congress abstracts, patents, book section, hypothesis articles, editorial, letters to the editor, news, protocols, interview, articles which are not written in English and that were not fully available even after attempting to contact the authors were also excluded. Articles were not excluded due to more than one exclusion criterion.
How has Tooth Manipulation been Conducted for Dental Pulp Stem Cells Isolation? A Scoping Review

Search Strategy

The electronic search was conducted without initial date restriction up to and including April 2014 in PubMed, Scopus, Scielo, and ISI Web of Knowledge databases to identify studies that described the methodology used for DPSCs isolation. An initial search was conducted using the following terms: “[dental pulp stem cell (MeSH)]; “[dental pulp (MeSH)]” and “[stem cell (MeSH)]; “[dental pulp stem cell” (MeSH)].” No language and date restrictions were applied in the search.

All references were managed in EndNote X7 software (Thomson Reuters, New York, NY, US). Initially, duplicate references were excluded. Titles, abstracts, and methodologies were screened based on the inclusion and exclusion criteria by two reviewers independently (CPF and CCdoA). Lists were compared, and in case of disagreement, a consensus was reached by discussion. When a consensus was not achieved, a third reviewer decided if the article should be included (FN). This scoping review followed the PRISMA statements with some adjustments (Fig. 1).

Data Extraction

After screening, the following data were collected from articles: name of authors, year of publication, donor’s age, donor’s gender, tooth type, time and tooth storage methods between the extraction and DPSCs isolation, tooth surface cleaning methods, location and methods of dental section, and methods used to remove the pulp from the dental chamber. Data were extracted and tabulated independently by two reviewers (CPF and RGS) to be submitted to a descriptive analysis. Cases of disagreement were discussed until a consensus was reached. When a consensus was not obtained, a third reviewer participated in the discussion (FN).

Assessment of Risk of Bias

Risk of bias was evaluated according to the following parameters for study quality assessment (a) donor’s age, (b) donor’s gender, (c) tooth type, (d) tooth storage methods, (e) tooth storage time, (f) dental surface cleaning (g) dental section methods (h) dental section location and (h) pulp removal methods. A parameter was given a “Y” (yes) if it was described in the study, if it was mentioned but not specifically, it was marked with a “U” (unclear); and finally if the parameter was not described, it was given an “N” (no). After the evaluation, the data were imported into Review Manager 5.3 for analysis and graph generation. Studies with up to 30% of “Y” had a high risk of bias, above 30% and lower than 65% had a medium risk, and above 65% low risk of bias.

RESULTS

Descriptive Analysis

The electronic search yield 3.126 articles. From those, 1.539 were duplicated and removed. A total of 1.587 articles were included by title, abstract, and methodology screening. From those, 222 were included for full-text analysis (Fig. 1).

Most of the studies were published in 2011 and 2013 (Supplementary material 1). Figure 2 shows that tooth donors are predominantly males with an age range from 17.5–30.6 years.

Of the studies included in this review, 84% described the type of tooth used for DPSCs isolation. The second most frequently mentioned item was the donor’s age (67.6%). However, the tooth storage time and method were the most neglected ones, described in 11.7% and 15%, respectively (Table 1).

Fig. 1: Flowchart with the studies selection process for inclusion in the systematic review (Exclusion reasons: a study could fulfill more than one criteria)
Concerning the type of teeth used for DPSCs isolation, data shows that the third molar is the most commonly used, at 77.6% or even higher since 9.2% reported just molars without specifying which one - first, second or third. The second most commonly used teeth are the premolars (10.7%). Supernumerary and incisors teeth represent 2.6%, and the canine was not mentioned in the studies (Table 2).

In relation to the storage method used to transport the newly extracted teeth to the site of DPSCs isolation, seven different types of solutions were cited. The most common was the same medium used subsequently for DPSCs culture (44% of the studies), followed by HBBS (20.6%). Considering the time spent between the extraction and isolation, the majority of authors (55.6%) conducted the isolation of DPSCs immediately after extraction and over 92% within 24 hours (Table 3).

Thirty-eight percent of the articles reported cleaning the tooth surface before sectioning the dental element to access the pulp chamber (Table 1). Thirteen cleaning solutions were mentioned, used alone or in combination with each other. PBS and CHX were the most cited solutions, each one used in 14.7% of the studies. CHX was used in concentrations of 0.2 and 0.3% as a solution or gel (Table 4).

In the normal procedure, after cleaning, the teeth are sectioned so that the pulp chamber and the pulp tissue can be access. However, only 37.8% of the papers reported the sectioning method (Table 1). The most used tools
How has Tooth Manipulation been Conducted for Dental Pulp Stem Cells Isolation? A Scoping Review

described were the fissure bur, forceps, and diamond discs, representing 24.7, 18.3, and 11.8%, respectively (Supplementary material 2).

Few studies indicated at which level the teeth were sectioned, of that 88.1% chose the cementum-enamel junction (CEJ) (Supplementary material 3).

More than 75% of the articles did not mention the methods used to remove the pulp tissue from inside the dental chamber (Table 1). Eight different instruments were used to remove the pulp tissue, the most common being the excavator, used in 59.7% of the studies. The second most used instrument was the forceps (11.7% of the studies, Supplementary material 4).

Table 4: Distribution according to the tooth surface cleaning method. Abbreviations: clorohexidina - CHX; phosphate buffered saline - PBS; Dulbecco's Phosphate-Buffered Saline - DPBS; povidone-iodine - PVP-I; Hank's Balanced Salt Solution - HBSS.

|                | N  | %  |
|----------------|----|----|
| CHX            |    |    |
| 0,2% solution  | 1  | 0.9|
| 0.3% solution  | 7  | 6.0|
| 0,3% gel       | 7  | 6.0|
| Not described  | 2  | 1.69|
| Solution       | 1  | 0.9|
| CHX total      | 17 | 14.7|
| PBS            | 17 | 14.7|
| Professional hygiene | 15 | 12.9|
| DPBS           | 9  | 7.8|
| Ethanol        | 9  | 7.8|
| PVP-I          | 8  | 6.9|
| Physiological solution | 4  | 3.5|
| Destilled water | 3  | 2.6|
| Sodium thiosulfate | 2  | 1.7|
| Sterile surgical blade | 1  | 0.9|
| HBSS           | 1  | 0.9|
| Dental burs    | 1  | 0.9|
| Dental scaler  | 1  | 0.9|
| Not described  | 28 | 24.1|
| Total          | 116| 100.0|

Risk of Bias

Of the 222 included studies, age and tooth type showed a low risk of bias (>65%). Dental surface cleaning and section methods showed the medium risk of bias (above 30% and lower than 65%). Donor’s gender, tooth storage methods, tooth storage time, section site and pulp removal methods presented a high risk of bias (<30%) (Supplementary material).

DISCUSSION

This scoping review demonstrates that DPSCs isolation has been reported since 2000. In the first five years following the discovery of DPSCs, only five articles were published. The number of publications increased in 2006 (5 publications) and continued to increase in the following years reaching its peak in 2013 (Fig. 3). Although great knowledge in DPSCs biology and its applications has been produced during these years, this scoping review shows the lack of standardization towards dental preparation before DPSCs isolation. This is the first time that the vast literature regarding tooth manipulation for DPSCs isolation has been summarized in a rigorous and replicable manner (Fig. 2).

The most commonly used teeth to obtain DPSCs were the third molars. According to Gronthos et al., DPSCs derived from molars have a greater degree of cell proliferation in vitro, when compared with bone marrow stem cells (BMSCs), and this behavior is attributed to differences in the development stage of each organ. In addition, third molars are easily accessible and commonly indicated for extraction for orthodontic reasons.

Most articles neglected the description of tooth donors’ gender (84%), and when described, males were the most prevalent donors (55.9%) (Table 1). Also, 67.6% of the articles mentioned the donor’s age (Supplementary material), with a range of 17.5–30.6 years. It has been reported that the final development of the lower and upper third molars occurs at the age of 21.6 and 22.3.

![Fig. 3: Risk of bias considering aspects reported in the material and method section](image-url)
such as dental burs, a dental scaler, and a sterile surgical blade. Some authors (12.9%) suggested professional oral prophylaxis before tooth extraction.

As pioneers in DPSCs isolation, Gronthos et al. provided the basis for many researchers. In agreement to their methodology, 88.1% of the included studies sectioned the tooth at the cementum-enamel junction, and 24.7% used dental fissure burs. To perform this step, a high-speed handpiece coupled to a dental unit is used. However, this equipment is often unavailable in most laboratories and therefore it is commonly performed in the clinic, jeopardizing the sterile environment needed to prevent contamination of the pulp tissue, and consequently the cell culture. In addition, the literature suggests that thermal damage should be avoided since a 5.5°C increase in intrapulpal temperature can cause irreversible damage to the pulp tissue. Subsequently, once the pulp chamber has been accessed, the next step is to remove the pulp tissue. Of all the articles included in this review, 75.7% did not mention this step. According to our findings, the use of excavators is the choice of approximately 60% of authors who mention the method used for dental pulp tissue removal.

After collecting the dental pulp, DPSCs can be isolated using two main techniques: explant and enzymatic. The association of the enzymatic technique and the use of mechanical devices to intensify cell dissociation is also frequently used.

This scoping review clearly shows the lack of information provided in articles, since a high risk of bias was found in almost all variables evaluated, with exception to donor’s age (67.6%) and tooth type (84.2%). We propose that information such as donor’s age, type of tooth, storage medium, storage time, tooth surface cleaning method, dental section method, tooth section site, and method for removing the pulp tissue from the chamber should be standardized and provided in all original articles, so that protocols could be well established. Based on the frequency that each step of DPSCs isolation was reported in our scoping review, we developed a platform (Fig. 2). However, it is important to highlight that this platform is based on frequency analysis and not in the effectiveness each step. We recognize that ideally the outcomes of the articles should be assessed instead of the frequency of the methods used.

Nonetheless, negative results are usually not published, and if outcomes were to be considered, they could lead to a great risk of bias. In addition, most studies included in this scoping review were not strictly methodological (evaluating only tooth manipulation) and assessed secondary outcomes. We can speculate, however, that if DPSCs isolation was described in the methodology section of studies evaluating secondary variables, the tooth manipulation method was successful. Therefore, we believe that the frequency of methods would be the most accurate data to evaluate.
CONCLUSION
Over the past 15 years, many studies have been conducted using DPSCs. However, there is a clear lack of standardization in tooth manipulation before DPSCs isolation. Thus, given a large number of variables in cell isolation techniques and its consequences in the \textit{in vitro} behavior of cells, it is important to reinforce the need for standard protocols to obtain a uniform cell culture.

CLINICAL SIGNIFICANCE
Tooth manipulation for DPSCs isolation is a complex task, dependent on aspects such as time and tooth storage methods between the extraction and DPSCs isolation, tooth surface cleaning methods, location and methods of the dental section, and methods used to remove the pulp from the dental chamber, which determine the success of stem cell isolation. The adequate process of cell isolation seems to be fundamental for the use of these cells as therapeutic tools in tissue engineering, cell therapy, and other health areas.

REFERENCES
1. Liu Y, Cao DL, Guo LB, et al. Amniotic stem cell transplantation therapy for type 1 diabetes: a case report. The Journal of international medical research. 2013;41(4):1370-1377.
2. Padda J, Sequiera GL, Sareen N, et al. Stem cell therapy for cardiac regeneration: hits and misses. Canadian Journal of Physiology and Pharmacology 2015;93(10):835-841.
3. de Souza PV, Alves FB, Costa Ayub CL, et al. Human immature dental pulp stem cells (hiDPSCs), their application to cell therapy and bioengineering: an analysis by systematic revision of the last decade of literature. Anatomical Record 2013;296(12):1923-1928.
4. Grotchos S, Mankani M, Brahim J, et al. Postnatal human dental pulp stem cells (DPSCs) \textit{in vitro} and \textit{in vivo}. Proc Natl Acad Sci USA 2000;97(25):13625-30.
5. Fischbach GD, Fischbach RL. Stem cells: science, policy, and ethics. The Journal of Clinical Investigation 2004;114(10):1364-1370.
6. Caplan AI. Why are MSCs therapeutic? New data: new insight. The Journal of Pathology 2009;217(2):318-324.
7. Kerkis I, Caplan AI. Stem cells in dental pulp of deciduous teeth. Tissue engineering Part B, Reviews 2012;18(2):129-138.
8. Moher D, Liberati A, Tetzlaff J, Altman DG, Group P. Preferred reporting items for systematic reviews and meta-analyses: the PRISMA statement. BMJ 2009;339:b2535.
9. Kellner M, Steinendorf MM, Strempel JF, et al. Differences of isolated dental stem cells dependent on donor age and consequences for autologous tooth replacement. Archives of Oral Biology 2014;59(6):559-567.
10. Jafari A, Mohabbi S, Khami M, et al. Radiographic evaluation of third molar development in 5- to 25 year olds in tehran, iran. Journal of Dentistry 2012;9(2):107-115.
11. Hartwig FP, Nedel F, Collares TV, et al. Telomeres and tissue engineering: the potential roles of TERT in VEGF-mediated angiogenesis. Stem Cell Reviews 2012;8(4):1275-1281.
12. Bellantuono I, Aldahmash A, Kassem M. Aging of marrow stromal (skeletal) stem cells and their contribution to age-related bone loss. Biochimica et biophysica acta. 2009;1792(4):364-371.
13. Ducret M, Fabre H, Degoul O, et al. Manufacturing of dental pulp cell-based products from human third molars: current strategies and future investigations. Frontiers in Physiology 2015;6:213.
14. Perry BC, Zhou D, Wu X, et al. Colletion, cryopreservation, and characterization of human dental pulp-derived mesenchymal stem cells for banking and clinical use. Tissue Eng Part C Methods 2008;14(2):149-156.
15. Aas JA, Paster BJ, Stokes LN, et al. Defining the normal bacterial flora of the oral cavity. Journal of Clinical Microbiology 2005;43(11):5721-5732.
16. Kim BC, Kim SY, Kwon YD, et al. Mycoplasma detection and elimination are necessary for the application of stem cell from human dental apical papilla to tissue engineering and regenerative medicine. Biomaterials research. 2015;19:19-6.
17. Xu H, Dongari-Bagtzoglou A. Shaping the oral mycobiot: interactions of opportunistic fungi with oral bacteria and the host. Current Opinion in Microbiology 2015;26:65-70.
18. Thomas A, Thakur S, Mhambre S. Comparison of the antimicrobial efficacy of chlorhexidine, sodium fluoride, fluoride with essential oils, alum, green tea, and garlic with lime mouth rinses on cariogenic microbes. Journal of International Society of Preventive & Community Dentistry 2015;5(4):302-308.
19. Jenkins S, Addy M, Wade W. The mechanism of action of chlorhexidine. A study of plaque growth on enamel inserts \textit{in vivo}. Journal of Clinical Periodontology 1988;15(7):415-424.
20. Visuri SR, Walsh JT, Jr., Wigdor HA. Erbium laser ablation of dental hard tissue: effect of water cooling. Lasers in Surgery and Medicine 1996;18(3):294-300.
21. Lizier NF, Kerkis A, Gomes CM, et al. Scaling-up of dental pulp stem cells isolated from multiple niches. PLoS One. 2012;7(6):e39885.
22. Kerkis I, Kerkis A, Dozortsev D, et al. Isolation and characterization of human immature dental pulp stem cells expressing OCT-4 and other embryonic stem cell markers. Cells, Tissues, Organs 2006;184(3-4):105-116.
23. Karamzadeh R, Eslaminejad MB, Aflatoonian R. Isolation of human dental pulp stem cells (DPSCs) \textit{in vitro} and \textit{in vivo}. Proc Natl Acad Sci USA 2000;97(25):13625-30.
24. Moher D, Liberati A, Tetzlaff J, Altman DG, Group P. Preferred reporting items for systematic reviews and meta-analyses: the PRISMA statement. BMJ 2009;339:b2535.
**SUPPLEMENTARY MATERIAL**

**Supplementary material 1.** Distribution of articles included in the systematic review according to the year of publication.

| Publication year | 2014 | 2013 | 2012 | 2011 | 2010 | 2009 | 2008 | 2007 | 2006 | 2005 | 2004 | 2003 | 2002 | 2001 | 2000 |
|------------------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|
| 2014             | Y    | N    | Y    | N    | Y    | N    | Y    | N    | Y    | N    | Y    | N    | Y    | N    | Y    | N    |
| 2013             | 27   | 47   | 28   | 42   | 16   | 31   | 15   | 37   | 6    | 5    | 1    | 1    | 0    | 0    | 1    | 0    |
| 2012             |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |
| 2011             |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |
| 2010             |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |
| 2009             |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |
| 2008             |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |
| 2007             |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |
| 2006             |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |
| 2005             |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |
| 2004             |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |
| 2003             |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |
| 2002             |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |
| 2001             |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |
| 2000             |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |

**Supplementary material 2:** Relation of the impact factor of the journals in the years of publications articles with the presence of variables of interest.

| Impact factor | Donors age | Donors gender | Tooth type | Tooth storage methods | Tooth storage time | Dental surface cleaning | Dental section method | Dental section location | Pulp removal methods |
|---------------|------------|---------------|------------|-----------------------|-------------------|------------------------|----------------------|----------------------|---------------------|
| Lower than 5  | Y: 88.2    | N: 11.8      | Y: 15.9    | N: 84.1               | Y: 100.0          | Y: 15.4               | Y: 84.6              | Y: 11.8              | Y: 88.2             |
|               | (150)      | (20)         | (27)       | (143)                 | (0)               | (26)                  | (143)                | (20)                 | (150)               |
| Higher than 5 | Y: 0.0     | N: 100       | Y: 18.5    | N: 81.5               | Y: 63             | Y: 36.5               | Y: 63.5              | Y: 35.3              | Y: 64.7             |
|               | (0)        | (27)         | (5)        | (22)                  | (17)              | (1)                   | (26)                 | (2)                  | (25)                |

**Supplementary material 3:** Distribution according to the method used for dental section.

| Method             | N  | %  |
|--------------------|----|----|
| Fissure bur        | 23 | 24.7|
| Forceps            | 17 | 18.3|
| Diamond discs      | 11 | 11.8|
| High speed         | 8  | 8.6 |
| Other 19 methods   | 34 | 36.6|
| Total              | 93 | 100.0|

**Supplementary material 4:** Distribution according to location of the dental section.

| Location                  | N  | %  |
|---------------------------|----|----|
| CEJ                       | 37 | 88.1|
| Root enamel boundary      | 4  | 9.5 |
| Crown-root border         | 1  | 2.4 |
| Total                     | 42 | 100.0|

CEJ, Cementum enamel junction
### Supplementary material 5: Distribution of data collected from articles to analyze the variables of interest

| Author and year of publication | Tooth                         | Cell type | Age at the extraction | Sex | Storage method for transporting | Storage time | Hygiene                                                                 | Methods section of tooth from the interior of the chamber |
|--------------------------------|-------------------------------|-----------|------------------------|-----|---------------------------------|-------------|------------------------------------------------------------------------|-------------------------------------------------------------|
| Abdullah 2014                  | DPSCs                         | 10-40 y   |                        |     | Immersion in 75% ethanol and soaking in PBS                              | Within 24 h |                                                                          |                                                             |
| Abu Kasim 2012                 | DPSCs                         | 24–35 y   |                        |     | Root surface cleaned with PVP-I (Sigma-Aldrich, St. Louis, MO, USA)     | 2 h         |                                                                          |                                                             |
| Agha-Hosseini 2010             | DPSCs                         | 18–28 y   |                        |     | Rinse mouth with CHX before extraction                                  |             | Small excavator                                                          |                                                             |
| Semi-impacted third molar      |                               |           |                        |     | Sterile dental probe                                                    |             |                                                                          |                                                             |
| Ahmed 2011                     | DPSCs                         | 20-29 y   |                        |     | DMEM (Biowhittaker, Gibco, Sigma, USA), penicillin/streptoycin (Invitrogen Co, USA) and 10% FBS (JRH biosciences, Inc., Lenexa, KS, USA) |             | Sterile dental probe                                                     |                                                             |
| Akkouch 2014                   | DPSCs                         | 18–25 y   |                        |     | PBS containing antibiotics, on ice                                      |             | Cut around the circumference of the teeth using a sterile hand-held high-speed drill at the CEJ level |                                                             |
| Al-Habib 2013                  | DPSCs                         | 16–24 y   |                        |     | Cell culture medium                                                     |             |                                                                          |                                                             |
| Alongi 2010                    | DPSCs-NPs                     | 14-22 y   |                        |     | Tissue freezing medium (Triangle Biomedical Sciences, Durham, NC, USA) or culture medium |             |                                                                          |                                                             |
| Armiñán 2009                   | DPSCs                         | 18-21 y   |                        |     |                                                                             |             |                                                                          |                                                             |

(Contd...)
| Author and year of publication | Tooth       | Cell type | Age at the extraction | Sex       | Storage method for transporting | Storage time | Hygiene                        | Methods section of tooth | Methods for removing the pulp from the interior of the chamber |
|-------------------------------|-------------|-----------|-----------------------|-----------|-------------------------------|--------------|--------------------------------|--------------------------|---------------------------------------------------------------|
| Arthur 2008                   | Impacted third molar | DPSCs     | 19-35 y               | Cleaned (not described) | Torno (vice) |                          |                          |                                           |                                           |
| Asgury 2014                   | Third molar | DPSCs     | Disinfected by 70% ethanol | Dissected at the crown-root border |                          |                          |                                           |                                           |
| Atari 2011                    | Third molar | DPMSMCs   | 14-60 y Male Female   | Washed using gauze soaked in 70% ethanol, followed by a wash with sterile destilled water | Hold the tooth with upper incisor forceps. The incision was in CEJ by using a cylindrical turbine bur | Sterile nerve-puller file 15 and forceps |                                           |                                           |
| Atari 2012 (a)                | Third molar | DPPSCs    | 18–27 y Male Female   | Washed using gauze soaked in 70% ethanol, followed by a wash with sterile destilled water | Hold the tooth with upper incisor forceps. The incision was in JEC by using a cylindrical turbine bur | Sterile nerve-puller file 15 and forceps |                                           |                                           |
| Atari 2012 (b)                | Third molar | DPPSCs    | 14–60 y Male Female   | Washed using gauze soaked in 70% ethanol, followed by a wash with sterile destilled water | Hold the tooth with upper incisor forceps. The incision was in JEC by using a cylindrical turbine bur | Sterile nerve-puller file 15 and forceps |                                           |                                           |
| Attar 2014                    | Molar       | PPSCs     | Teeth cut around the root enamel boundary using dental fissure bur |            |                                |                                           |                                           |                                           |
| Bakopoulou 2011               | Impacted third molar | DPSCs | 16-18 y               | Cleaned (not described) | Cut around the CEJ |                                           |                                           |                                           |
| Author and year of publication | Tooth                  | Cell type | Age at extraction | Sex         | Storage method for transporting | Storage time | Hygiene                                      | Methods section of tooth | Methods for removing the pulp from the interior of the chamber |
|--------------------------------|------------------------|-----------|-------------------|-------------|---------------------------------|--------------|---------------------------------------------|--------------------------|---------------------------------------------------------------|
| Batouli 2003                   | Impacted third molar   | DPSCs     | 19-29 y           | Male        |                                 |              |                                             | Dentinal excavator or a gracey curette |                                                              |
| Bonnamain 2013                 | Non-erupted third molar| DPSCs     | 15–20 y           | Female      |                                 |              |                                             | Mechanical fracturing |                                              |
| Bressan 2012                   | Molar                  | DPSCs     | 16-66 y           |             | Pretreatment for one week with professional dental hygiene. Before extraction dental crown covered with 0.3% CHX gel (Forhans, New York, NY) for 2 min |              |                                             | Mechanical fracturing | Dentinal excavator or a gracey curette                    |
| Cai 2011                       | Impacted third molar   | hDPSCs    | 18-28 y           |             |                                 |              |                                             | Dentinal excavator or a gracey curette |                                                              |
| Carinci 2008                   | Molar                  | hDPSCs    |                   |             |                                 |              |                                             | Mechanical fracturing | Dentinal excavator or a gracey curette                    |
| Carvalho 2012                  | Upper third molar      | hDP-DPSCs |                   |             | Cleaned (not described)         |              |                                             | Mechanical fracturing | Dentinal excavator or a gracey curette                    |
| Chen 2012                      | Third molar            | DPSCs     | 19-23 y           |             | α-MEM serum free (Hyclone, Logan, UT, USA) | 1 h          |                                             | Mechanical fracturing | Dentinal excavator or a gracey curette                    |
| Chen 2013                      |                        | hDPSCs    |                   |             | Mean of 26.5 y                  |              |                                             | Mechanical fracturing |                                            |
|                                |                        | hDPSCs    |                   |             | Mean of 23.4 y                  |              |                                             | Mechanical fracturing |                                            |

(Contd...)
| Author and year of publication | Tooth | Cell type | Age at the extraction | Sex | Storage method for transporting | Storage time | Hygiene | Methods section of tooth | Methods for removing the pulp from the interior of the chamber |
|-------------------------------|-------|-----------|-----------------------|-----|-------------------------------|-------------|--------|--------------------------|-------------------------------------------------------------|
| Chen 2011                     | hDPSCs | Mean of 25.5 y, 6–74 y | Male | Female | Cleaned the tooth surface with DPBS | A circumference groove of 0.5–1.0 mm in depth was cut around the entire tooth using an aseptic high speed handpiece. The tooth was split using a chisel. |
| Choi 2012                     | Molar | DPSCs | Mean of 26.5 y, 6-74 y | Freshly derived dental pulp tissues liq N2- | Stored (not described) | Dental high-speed unit |
| Chun 2011 (a)                 | Third molar | DPSCs | Mean of 19 y, 12-23 y | Male | Stored (not described) | Cleaned (not described) |
| Chun 2011 (b)                 | DPSCs |            |                        |     |                                |              |
| Cmielova 2013                 | Impacted third molar | DPSCs | Mean of 23.4 y, 6-49 y |                               |                                |              |
| Collart-Dutilleul 2014        | Impacted third molar | DPSCs | Mean of 27.7 y, 8-52 y |                               |                                |              |
| Collart-Dutilleul 2014        | Impacted third molar | DPSCs | Mean of 27.7 y, 8-52 y |                               |                                |              |
| Collart-Dutilleul 2014        | Impacted third molar | DPSCs | Mean of 27.7 y, 8-52 y |                               |                                |              |
| Collart-Dutilleul 2014        | Impacted third molar | DPSCs | Mean of 27.7 y, 8-52 y |                               |                                |              |
| Author and year of publication | Tooth | Cell type | Age at the extraction | Sex | Storage method for transporting | Storage time | Hygiene | Methods section of tooth | Methods for removing the pulp from the interior of the chamber |
|--------------------------------|-------|-----------|-----------------------|-----|-------------------------------|--------------|--------|------------------------|--------------------------------------------------|
| Cui 2014                       | Third molar | hDPSCs |                       |     |                               |              |        |                        |                                                  |
| Cui 2013                       | Third molar | hDPSCs |                       |     |                               |              |        |                        |                                                  |
| Dai 2012                       | Third molar | DPSCs  | Mean of 18+ -3.2, 16-25 y |     |                               |              |        |                        |                                                  |
| D’Alimonte 2013                | DPSCs  | Mean of 17 y | Male | Female | Professional oral hygiene one week before surgery 0,2% CHX after brushing, twice a day | Surgical drill |       |                        |                                                  |
| D’Alimonte 2011                | DPSCs  | Mean of 17 y | Male | Female | Professional oral hygiene one week before surgery 0,3% CHX after brushing, twice a day | Surgical drill | Dentinal excavator or a gracey curette |                                                   |
| D’Aquino 2009                  | Third molar | DPSCs  | Male | Female | Professional oral hygiene one week before surgery 0,2% CHX after brushing, twice a day | Surgical drill |       |                        |                                                  |
| D’Aquino 2007                  | DPSCs  | Male | Female | Professional oral hygiene one week before surgery 0,3% CHX after brushing, twice a day | Surgical drill | Dentinal excavator or a gracey curette |                                                   |
| de Rosa 2011                   | DPSCs  | 21-45 y | Cleaned (not described) |                                 | Longitudinal groove and sterilized diamond discs (KGSorensen, ref.7020, Zenith Dental ApS, AgersKov, Denmark) | Sterile dentinal excavator |                                                   |
| de Souza 2010                  | Impacted third molar | DPCp  | 9-15 y |                                 |                                 |                           |                                                   |
| Demircan 2011                  | Molar | hDP-SC  | 20 y | Male | Immersion in physiologic solution containing antibiotics | Pliers (bone forceps) |    |                        |                                                  |

(Contd...)
| Author and year of publication | Tooth                | Cell type   | Age at the extraction | Sex | Storage method for transporting | Storage time | Hygiene                                                                 | Methods section of tooth                                      | Methods for removing the pulp from the interior of the chamber |
|-------------------------------|----------------------|-------------|-----------------------|-----|---------------------------------|--------------|----------------------------------------------------------------------|---------------------------------------------------------------|---------------------------------------------------------------|
| Diomede 2013                  | Premolar             | hDPSCs      | 18-25 y               |     | Rinsed five times with PBS      |              |                                                                       | Cylindrical diamond bur (314, Ø ISO 014, L, 8.0mm) mounted on a high speed handpiece (Bora L, Bien Air, Bienne, Switzerland) with water spray cooling | Sterile excavator                                              |
| Dissanayaka 2012              | Third molar          | DPSCs       | 18-25 y               |     | Cleaned (not described)         |              |                                                                       | Sterile fissure bur at the CEJ                               |                                                               |
| Dissanayaka 2011              | Third molar          | hDPSCs      |                       |     | Cleaned (not described)         |              |                                                                       | Cut at the CEJ by using a sterile fissure bur                 |                                                               |
| Djouad 2010                   | Third molar          | DP-MPCs     | 16-26 y               |     |                                 |              |                                                                       |                                                               |                                                               |
| Dolatshahi-Pirouz 2010        | Third molar          | DP-MSC      | 21 y                  |     |                                 |              |                                                                       |                                                               |                                                               |
| Duailibi 2011                 | Mandibular third molar | DSCs       |                       |     | HBSS (Gibco BRL, Gaithersburg, MD, USA) pre-warmed 37°C |              |                                                                       |                                                               |                                                               |
| Ebrahimi 2011                 | DPSCs                |             |                       |     | Disinfected in iodine solution, washed with PBS |              |                                                                       | Cracked using a turbine along the cervical region and with sterilized cowhorn forceps |                                                               |
| Author and year of publication | Tooth | Cell type | Age at the extraction | Sex | Storage method for transporting | Storage time | Hygiene | Methods section of tooth | Methods for removing the pulp from the interior of the chamber |
|--------------------------------|------|----------|-----------------------|-----|-------------------------------|-------------|---------|-------------------------|-------------------------------------------------------------|
| Egbuniwe 2011                  | Third molar | tDPSCs | 20-25 y               | Male | Washed with 70% ethanol and then with HBSS (Invitrogen) pH 7.4 | Immediately 24 h at 4°C | Sterile forceps | Horizontal indentations along the cervical margin using a low speed circular diamond saw (Agar Scientific Ltd.) | Sterile forceps |
| Eleutério 2013                 | Premolar teeth | DPSCs | 20-35 y               | | Professional oral hygiene one week before surgery. Cleaned with PBS containing penicillin and streptomycin | | Sterile dentinal excavator | Vertical indentations along the cervical margin using a high-speed diamond saw (Agar Scientific Ltd.) | Sterile dentinal excavator |
| Eslaminejad 2013               | Third molar | DPSCs | 20-25 y               | Male | Cylindrical diamond rotary cutting instrument mounted on a high-speed handpiece with water-spray cooling | | Sterile dentinal excavator | Vertical indentations along the cervical margin using a high-speed diamond saw (Agar Scientific Ltd.) | Sterile dentinal excavator |
| Eslaminejad 2010 (a)           | Third molar | DPSCs | 20-25 y               | Male | Cut around the root-enamel boundary using dental fissure bur | | Sterile dentinal excavator | Vertical indentations along the cervical margin using a high-speed diamond saw (Agar Scientific Ltd.) | Sterile dentinal excavator |
| Eslaminejad 2010 (b)           | Third molar | DPSCs | 20-25 y               | | Cut around the root-enamel boundary using dental fissure bur | | Sterile dentinal excavator | Vertical indentations along the cervical margin using a high-speed diamond saw (Agar Scientific Ltd.) | Sterile dentinal excavator |
| Eslaminejad 2009               | Third molar | DPSCs | 20-25 y               | | Cut around the root-enamel boundary using dental fissure bur | | Sterile dentinal excavator | Vertical indentations along the cervical margin using a high-speed diamond saw (Agar Scientific Ltd.) | Sterile dentinal excavator |
| Eubanks 2014                   | DPSCs | 15–22 y | Sterile saline solution or α-MEM containing 15% FBS | | Cut above the CEJ | | Sterile dentinal excavator | Vertical indentations along the cervical margin using a high-speed diamond saw (Agar Scientific Ltd.) | Sterile dentinal excavator |
| Author and year of publication | Tooth | Cell type | Age at the extraction | Sex | Storage method for transporting | Storage time | Hygiene | Methods section of tooth | Methods for removing the pulp from the interior of the chamber |
|-------------------------------|-------|-----------|-----------------------|-----|---------------------------------|-------------|--------|------------------------|-------------------------------------------------------------|
| Fang 2013                     | Third molar | DPSCs | 16-30 y |       | Culture medium containing 100 U/mL penicillin and 100 mg/mL streptomycin |             | Desinfected with PVP-I for 5 min PBS containing 100 U/mL penicillin and 100 mg/mL streptomycin |             |                                          |
| Fang 2013 (a)                 | Impacted third molar | DPSCs | 13-23 y |       | Cleaned (not described) |             | Cutting around the CEJ using sterilised dental fissure bur |             |                                          |
| Fang 2014                     | Impacted third molar | DPSCs | 13-23 y |       | Cleaned (not described) |             | Cutting around the CEJ using sterilised dental fissure bur |             |                                          |
| Fang 2013 (b)                 | Impacted third molar | DPSCs | 45-50 y |       | Dental pulp tissue was washed three times with PBS |             |         | MOD.31W hand excavator |                                          |
| Foudah 2014                   | Third molar | hDPSCs |       |       | PBS | Maximum of 1h | Piezoelectric ultrasonic device (OT7 insert) under abundant irrigation with sterile 0.9% NaCl |             |                                          |
| Gabanyi 2013                  | Third molar |       |       |       | Cleaned (not described) |             |         |                        |                                          |
| Gandia 2008                   | Third molar | DPSCs | 18-21 y |       | DMEM containing 10% FBS, 1% penicilin and streptomycin | 72 h |         |                        |                                          |
| Gay 2014                      | Third molar | DPSCs |       |       |                  |             |         |                        | Cut around the CEJ using sterilized dental fissure bur |                                          |
| Giorgini 2011                 | Third molar | DPSCs | 18-20 y |       | Cleaned (not described) |             |         |                        |                                          |
| Author and year of publication | Tooth | Cell type | Age at the extraction | Sex | Storage method for transporting | Storage time | Hygiene | Methods section of tooth | Methods for removing the pulp from the interior of the chamber |
|-------------------------------|-------|-----------|-----------------------|-----|---------------------------------|--------------|---------|------------------------|---------------------------------------------------------------|
| Govindasamy 2010 (a)          | Third molar | DPSCs    | 24-35 y               |     |                                 | 2 h          | Root surfaces were cleaned with PVP-I (Sigma Aldrich, St Louis, MO) |                                               |
| Govindasamy 2011              | Third molar | DPSCs    | 24 – 35 y             |     | 1 X DMEM-KO, 10% FBS, 2% penicillin, 2% streptomycin, 5% GlutaMax, 100 mg/mL ascorbic acid, 1X ITS | 2 h          | Root surfaces were cleaned with 100% PVP-I (Sigma Aldrich, St Louis, MO) |                                               |
| Govindasamy 2010 (b)          |       | DPSCs    | 14–25 y               |     |                                 |              |                                     |                                               |
| Graziano 2008                 |       | SBP-DPSC | 21–45 y               |     | Petreated for a week with professional dental hygiene. Before extraction, the dental crown was covered with a 0.3% CHX (Forhans, New York, NY) for 2 min |              | Dentinal excavator or gracey curette |                                               |
| Graziano 2007                 |       | SBP-DPSC | 25-45 y               |     | Petreated for a week with professional dental hygiene. Before extraction, the dental crown was covered with a 0.3% CHX (Forhans, New York, NY) for 2 min |              | Dentinal excavator or gracey curette |                                               |
| Author and year of publication | Tooth Type | Cell type | Age at the extraction | Sex | Storage method for transporting | Storage time | Hygiene | Methods section of tooth | Methods for removing the pulp from the interior of the chamber |
|-------------------------------|------------|-----------|-----------------------|-----|--------------------------------|--------------|--------|-------------------------|-------------------------------------------------|
| Gronthos 2000                 | Impacted third molar | DPSCs | 19-29 y |       |                               |              | Cleaned (not described) | Cut around the CEJ by using sterilized dental fissure bur |
| Han 2008                      | Third molar | DPSCs |         |       |                               |              | Tooth was washed with PBS containing AA solution for 3 min after washing with 70% ethanol | |
| Han 2010                      | Third molar | DPSCs |         |       |                               |              | Tooth was washed with PBS containing AA solution for 3 min after washing with 70% ethanol | Severed with pliers |
| Haveleck 2013                 | Impacted third molar | DPSCs |         |       |                               |              | Cleaned (not described) | Mechanically fractured with forceps |
| He 2008                       | Impacted third molar | DPSCs | 19-29 y |       |                               |              | Cleaned (not described) | Cut around the CEJ by using sterilized dental fissure bur |
| He 2013                       | Impacted third molar | hDPSCs | 18-22 y |       |                               |              | Cleaned (not described) | Barbed broach |
| Hilkens 2013                  | Third molar | DPSC-EZ | 15-20 y |       | DPSC-OG                        |              | Cleaned (not described) | Cut around the CEJ by using sterilized dental fissure bur |
| Hirata 2010                   | Third molar upper |       |         |       |                               |              | Cleaned (not described) | Brushed by using sterilized dental burs |
| Hoss 2013                     | Impacted third molar | DPSCs |         |       |                               |              | Brushed by using sterilized dental burs | Endodontic file |
| Huang 2009                    | Left upper central incisor - traumatized | hDPSCs | 41 y |       |                               |              | Endodontic file | |

(Contd...)
| Author and year of publication | Tooth                                | Cell type | Age at the extraction | Sex | Storage method for transporting | Storage time | Hygiene                                      | Methods section of tooth |
|--------------------------------|--------------------------------------|-----------|-----------------------|-----|-------------------------------|--------------|---------------------------------------------|--------------------------|
| Huang 2008                     | Supernumerary tooth (a mesiodens)    | DPSCs     | 20 y                  | Male| DPBS, on ice (Invitrogen Carlsbad, CA, USA) |              | Cleaned with DPBS (Invitrogen, Carlsbad, CA, USA) | Sterile hand-held high-speed drill. Cut around the circumference of the teeth with chisel. |
| Huang 2010 (a)                 | Third molar                          | DPSCs     | 14-22 y               |     |                               |              |                                             |                          |
| Huang 2010 (b)                 | Impacted third molar                 | DPSCs     | 16–24 y               |     | Cell culture medium, serum-free |              |                                             |                          |
| Ishkitiev 2010                 | Upper third molar                    | DPSCs     |                       |     |                               |              | Cleaned (not described)                     | Cut around the CEJ by using sterilized dental fissure bur |
| Ishkitiev 2012                 | Third molar                          | DPSCs     |                       |     |                               |              | Cleaned (not described)                     | Cut around the CEJ by using sterilized dental fissure bur |
| Jeon 2011                      | Impacted third molar                 | DPuSCs    | 16–18 y               |     | D-PBS, on ice                 |              | Cleaning with DPBS containing 1% penicillin (Gibco), streptomycin (Gibco) | Sterile barbed broach |
| Jin 2013                       | Third molar                          | hDPSCs    | 18-25 y               |     |                               |              |                                             |                          |
| Kadar 2009                     | Impacted third molar                 | DPSCs     | 18-26 y               |     |                               |              | Cleaned (not described)                     | Cut around the CEJ by using sterilized dental fissure bur |
| Kanafi 2014                    | DPSCs                                |           | 18-40 y               |     |                               |              |                                             |                          |
| Kanafi 2013 (a)                | DPSCs                                |           | 5-40 y                |     |                               |              |                                             |                          |
| Kanafi 2013 (b)                | DPSCs                                |           | 5 - 40 y              |     |                               |              | Washed 2–3 times with DPBS (Invitrogen, Calif., USA) |                          |
| Kanafi 2013 (c)                | DPSCs                                |           | 5 - 40 y              |     |                               |              |                                             |                          |
| Author and year of publication | Tooth | Cell type | Age at the extraction | Sex | Storage method for transporting | Storage time | Hygiene | Methods section of tooth | Methods for removing the pulp from the interior of the chamber |
|-------------------------------|-------|-----------|-----------------------|-----|-------------------------------|-------------|--------|------------------------|---------------------------------------------------|
| Kanafi (d)                    | Third molar | DPSCs | 18-30 y               |      |                                |             |        |                        | Immersion in physiological solution containing antibiotics |
| Karaooz 2011                  | Third molar | DPSCs | 17-25 y               |      |                                |             |        |                        | Cut around the CEJ by using sterilized dental fissure bur |
| Karbanová 2010                | Impacted third molar | DPSCs | 17-23 y               |      |                                |             |        |                        | Sterile excavator |
| Karbanová 2011                | Impacted third molar | DPSCs | 17-23 y               |      |                                |             |        |                        |                                                                 |
| Kawanabe 2012                 | Premolar | DP     | 18-27 y               |      |                                |             |        |                        |                                                                 |
| Kalner 2014                   | Impacted third molar | DPSCs | 12-30 y               |      |                                |             |        |                        |                                                                 |
| Khanna-Jain 2012              | Impacted third molar | DPSCs | Mean of 23 ± 2.5 years, 21–26 y |      |                                |             |        |                        |                                                                 |
| Kim 2013                      | Third molar | hDPSCs |                      |      |                                |             |        |                        |                                                                 |
| Kim 2011                      | Premolar | DPSCs | 18 and 19 y           | Male |                                |             |        |                        | Cut around the CEJ using by sterilized dental disk |
| Király 2011                   | Impacted third molar | DPSCs | 19-35 y               |      |                                |             |        |                        |                                                                 |
| Király 2009                   | Impacted third molar | DPSCs | 19–55 y               |      |                                |             |        |                        |                                                                 |
| Kolind 2014                   | Impacted third molar | DPSCs |                      |      |                                |             |        |                        |                                                                 |
| Koyama 2009                   | Impacted third molar | DPSCs | 14-35 y               |      |                                |             |        |                        | Cut around the CEJ by using sterilized dental fissure bur |
| Kraft 2010                    | Impacted third molar | PDSC- immature PDSC- mature | 21 y | Male |                              | 20 y        | Female |                        |                                                                 |
| Laino 2006                    | Third molar | DPSCs | 19-37 y               |      |                                |             |        |                        |                                                                 |

(Contd...)
| Author and year of publication | Tooth | Cell type | Age at the extraction | Sex | Storage method for transporting | Storage time | Hygiene | Methods section of tooth | Methods for removing the pulp from the interior of the chamber |
|-------------------------------|-------|-----------|-----------------------|-----|---------------------------------|-------------|---------|-------------------------|-------------------------------------------------------------|
| Laino 2005                    | DPSCs | 30-45 y   |                       |     | Pretreated a week before        |             |         |                         | Gracey curette                                               |
|                               |       |           |                       |     | with professional dental hygiene. Before extraction, the dental crown was covered with 0.3% CHX gel (Forhans) for 2 min |
| Lee 2014                      | DPSCs | 18-39 y   |                       |     | Cleaned (not described)         |             |         |                         |                                                             |
| Lee 2008                      | Molar | hDPSCs    |                       |     | Cut around the CEJ by using sterilized dental fissure bur |
| Lee 2011 (a)                  | Third molar | hDPSCs |                       |     | Forceps                         |             |         |                         |                                                             |
| Lee 2011 (b)                  | Impacted third molar | hDPSCs | 18-22 y               |     | Dental high-speed unit          |             |         |                         |                                                             |
| Lee 2011 (c)                  | Molar | DPSCs     |                       |     | HBBS (Welgene, Dae-gu, Korea) supplemented with 3% AA (Gibco, Grand Island, NY) at 4°C |
| Lee 2010 (a)                  | Molar | hDPSCs    |                       |     | CHX solution                     |             |         |                         | Hercules cutter                                               |
| Lee 2010 (b)                  | Third molar | DP-MSCs | 17-38 y               | Male| Magnetically cryopreserved: Cryopreserved in a program freezer (ABI, Chiba, Japan) supplied with a slight magnetic field. Teeth were transported at 4°C and then placed in a freezer at -5°C. |
| Lee 2010 (c)                  | Premolar | DPSCs   | 18-30 y               |     | Cleaned with PBS                 |             |         | 15 min                  |                                                             |
| Author and year of publication | Tooth                | Cell type | Age at the extraction | Sex   | Storage method for transporting | Storage time | Hygiene                        | Methods for removing the pulp from the interior of the chamber |
|--------------------------------|----------------------|-----------|-----------------------|-------|----------------------------------|--------------|--------------------------------|---------------------------------------------------------------|
| Lee 2012                       | Incisor              | DPSCs     | 28 y                  | Male  | Cleaned with DPBS                | 84 h         | Non-cryopreserved fresh teeth  |                                                               |
|                                |                      |           | 25 y                  | Female|                                   |              |                                |                                                               |
| Lee 2011 (d)                   | Third molar          | DPSCs     | 18-35 y               |       |                                   |              |                                |                                                               |
| Li 2011                        |                      | hDPSCs    | 19-22 y               | Male  |                                   |              |                                |                                                               |
| Lin 2011                       | Third molar          | DPSCs     | 25 y                  | Male  | Cleaned with PBS                 |              | Diamond burs                   | Forceps                                                      |
|                                |                      |           | 18 y                  | Female|                                   |              |                                |                                                               |
| Lindroos 2008                  | Impacted third molar | DPSCs     | 21-31 y               |       |                                   |              |                                |                                                               |
| Liu 2014                       |                      | DPSCs     |                       |       |                                   |              |                                |                                                               |
| Luo 2014 (a)                   |                      | hDPSCs    | 18-25 y               |       |                                   |              |                                |                                                               |
| Luo 2014 (b)                   |                      | hDPSCs    |                       |       |                                   |              |                                |                                                               |
| Ma 2012                        | Third molar          | DPSCs     | 18-28 y               |       |                                   |              |                                |                                                               |
| Author and year of publication | Tooth | Cell type | Age at the extraction | Sex | Storage method for transporting | Storage time | Hygiene | Methods for removing the pulp from the interior of the chamber |
|-------------------------------|-------|-----------|----------------------|-----|-------------------------------|-------------|---------|-----------------------------------------------------------|
| Makino 2013                   | Supernumerary | SNTSCs |                      |     |                               |             |         | Pretreatment for one week with professional dental hygiene. Before extraction dental crown covered with 0.3% CHX gel (Forhans, New York, NY) for 2 min | Dentinal excavator or a gracey curette |
| Mangano 2010                  | Third molar | DPSCs |                      |     | Pretreatment for one week with professional dental hygiene. Before extraction dental crown covered with 0.3% CHX gel (Forhans, New York, NY) for 2 min | Dentinal excavator or a gracey curette |
| Manikandhan 2010              | Molar | DPSCs | 6-48 h               |     | Sterile diamond bur |             |         | Immersion d in PBS containing AA: 100 U/mL penicillin, 100µg/mL streptomycin, 0.25 µg/mL amphotericin B. Then, immersion in a 0.2% CHX solution. | |
| Marchionni 2009               | Molar | DP-SCs | Mean of 35 y         |     |                               |             |         | Sterile diamond bur | |

(Contd...)
| Author and year of publication | Tooth | Cell type | Age at the extraction | Sex | Storage method for transporting | Storage time | Hygiene | Methods section of tooth | Methods for removing the pulp from the interior of the chamber |
|--------------------------------|-------|-----------|-----------------------|-----|---------------------------------|-------------|---------|----------------------|-----------------------------------------------------|
| Martens 2012                   | Third molar | hDPSCs | 18-24 y               |     | DMEM (Sigma-Aldrich, Steinheim, Germany) supplemented with 6% AA : 10,000 U/mL penicillin (Sigma Aldrich) 10 ng/mL streptomycin (Sigma-Aldrich) and 25 mg/mL amphotericin B (Sigma-Aldrich) | Immediately | Rinsed with PBS (Sigma-Aldrich). Periodontal tissues over the root surface were removed with a sterile surgical blade | Mechanically |
| Martin 2013                    | Third molar | hDPSCs | Mean of 22.5 y        |     |                                |             |         | Sterilized diamond bur |
| Min 2011                       | Third molar | DPCs   | 20-25 y               |     |                                 |             |         |                     |
| Mokry 2010                     | Impacted third molar | DPSCs | 18-27 y               | Male |                                 |             |         |                     |
| Mori 2011                      | Third molar | DPSCs | 20-27 y               | Female | Cleaned (not described) |             |         | Cut around CEJ by using sterilized dental fissure bur |
| Murakami 2013                  | Third molar | DPSCs | 18-29 y               |     |                                 |             |         |                     |
| Murakami 2012                  | Third molar | DPSCs | 18-29 y               |     |                                 |             |         |                     |
| Muthna 2010                    | Impacted third molar | DPSCs | 12-23 y               | Male |                                 |             |         |                     |
| Nadeem 2013                    | Third molar | DPSCs |                      | Female |                                 |             |         |                     |
| Nakamura 2009                  | DPSCs |                      |             |     |                                 |             |         |                     |
| Nam 2011                       | Third molar | hDPSCs | 19-25 y               |     |                                 |             |         |                     |
| Navabazam 2013                 | Third molar | DPSCs | 15-32 y               |     |                                 |             |         |                     |
| Author and year of publication | Tooth | Cell type | Age at the extraction | Sex | Storage method for transporting | Storage time | Hygiene | Methods for removing the pulp from the interior of the chamber |
|--------------------------------|-------|-----------|-----------------------|-----|--------------------------------|--------------|---------|-------------------------------------------------------------|
| Nawi 2013                      |       | DPSCs     |                       |     | HBSS                           | Immediately  | Periodontal and gingival tissues were scrapped off from the tooth surface using sterile surgical blade. Surface was cleaned with iodone and 70% ethanol. Then, washed with DPBS | Cut a the CEJ by using hard tissue cutter (Exact, Düsseldorf, Germany) |
| Nawi 2013                      |       | DPSCs     |                       |     | HBSS                           | Immediately  | Periodontal and gingival tissues were scrapped off from the tooth surface using sterile surgical blade. Surface was cleaned with iodone and 70% ethanol. Then, washed with DPBS | Cut a the CEJ by using hard tissue cutter (Exact, Düsseldorf, Germany) |
| Nesti 2011                     | Molar | DPSCs     | 18-35 y               |     |                                |              | Cleaned (not described) | Cut around the CEJ by using sterilized dental bur |
| Neuss 2008                     | Impacted third molar | DPSCs |                          |     |                                |              | Cleaned (not described) | Cut around the CEJ by using sterilized dental bur |
| Niu 2014                       | Third molar | hDPSCs | 18-25 y               |     |                                |              | Pretreatment for a week with professional dental hygiene | Dentinal excavator or a gracey curette |
| Oancea 2013                    | Third molar | DPSCs | 12-17 y               |     |                                |              | Pretreatment for a week with professional dental hygiene | Dentinal excavator or a gracey curette |
| Okamoto 2009                   | Third molar | DPSCs | 22-26 y               |     |                                |              | Pretreatment for a week with professional dental hygiene | Dentinal excavator or a gracey curette |
| Osathanon 2011                 | Impacted third molar | DPSCs |                          |     |                                |              | Pretreatment for a week with professional dental hygiene | Dentinal excavator or a gracey curette |
| Osathanon 2014                 | Impacted third molar | DPSCs |                          |     |                                |              | Pretreatment for a week with professional dental hygiene | Dentinal excavator or a gracey curette |
| Paino 2010                     | Molar | DPSCs     |                       |     |                                |              | Pretreatment for a week with professional dental hygiene. Before extraction, the dental crown was covered with 0.3% CHX gel (Forhans, NY) for 2 min. | Dentinal excavator or a gracey curette |
| Palumbo 2013                   | Third molar | hDPSCs |                          |     |                                |              | Pretreatment for a week with professional dental hygiene. Before extraction, the dental crown was covered with 0.3% CHX gel (Forhans, NY) for 2 min. | Dentinal excavator or a gracey curette |
| Pang 2013                      | Third molar | DPSCs | 16-22 y               |     |                                |              | Pretreatment for a week with professional dental hygiene. Before extraction, the dental crown was covered with 0.3% CHX gel (Forhans, NY) for 2 min. | Dentinal excavator or a gracey curette |
| Papaccio 2006                  | Third molar | hDPSCs | 21-45 y               |     |                                |              | Pretreatment for a week with professional dental hygiene. Before extraction, the dental crown was covered with 0.3% CHX gel (Forhans, NY) for 2 min. | Dentinal excavator or a gracey curette |

(Contd...)
| Author and year of publication | Tooth | Cell type | Age at the extraction | Sex | Storage method for transporting | Storage time | Hygiene | Methods for removing the pulp from the interior of the chamber |
|-------------------------------|-------|-----------|-----------------------|-----|-------------------------------|-------------|---------|---------------------------------------------------------------|
| Park 2013                     | Impactec third molar | hDPSCs | 18-35 y               |     | Rinsed several times with DPBS containing 1% penicillin and 1% streptomycin |            |         | Bone forceps                                                 |
| Patil 2014                    | Third molar | DPSCs | 16-18 y               | Male |                                |             |         | Bone forceps                                                 |
| Pereira 2012 (a)              | Molar | N-hDPSCs | 17-43 y              |     | Sterilized diamond discs and dental surgical elevator |            |         | Sterile dentinal excavator                                  |
| Pereira 2012 (b)              | DPSCs-N | I-hDPSCs | 17-43 y              |     | Sterilized diamond discs (KG Sorensen, ref. 7020, Barueri, São Paulo, Brazil) and dental surgical elevator |            |         | Sterile dentinal excavator                                  |
| Perry 2008                    | Third molar | DPSCs | 18-30 y               |     | 20mL of one of three collection/transport solutions: HTS (BioLife Solutions, Bothell, WA) MesenCult basal medium (Stem Cell Technologies, Vancouver, Canada), PBS (Sigma Chemical, St. Louis, MO) | Immediately | Washed with sterile PBS, followed by immersion in 1% PVP-I for 2 min, immersion in 0.1% sodium thiosulfate in PBS for 1 min, and another wash in sterile PBS | |
| Picchi 2013                   | Molar |                    |                      |     |                               |             |         | Gracey curette                                               |
| Pierdomenic 2005              | Molar | DP-MSCs | Mean of 40 y          | Male | Immediately |              | Immersion in physiological solution containing antibiotics | Bone forceps |
| Author and year of publication | Tooth                | Cell type | Age at the extraction | Sex | Storage method for transporting | Storage time | Hygiene | Methods for removing the pulp from the interior of the chamber |
|--------------------------------|----------------------|-----------|-----------------------|-----|---------------------------------|--------------|---------|---------------------------------------------------------------|
| Ponnaiyan 2012                 | Impacted third molar | DPSCs     | 18-22 y               |     |                                 |              |         |                                                               |
| Riccio 2010                    | Third molar          | DPSCs     | 18-35 y               |     |                                 |              |         |                                                              |
| Rizk 2013 (a)                  | Premolar             | DPSCs     |                       |     |                                 |              |         | Bone cutter                                                  |
| Risk 2013 (b)                  | Premolar             | hDPSCs    |                       |     |                                 |              |         |                                                              |
| Rodriguez-Lozano 2012          | Impacted third molar | DPSCs     | Mean of 29 y, 21-45 y | Male|                                 |              | Female  |                                                              |
| Rodriguez-Lozano 2013          | Impacted third molar | DPSCs     |                       |     | DMEM supplemented with 10% of FCS, 100 U/mL penicillin and 100 µg/mL streptomycin | 24 h         |         |                                                              |
| Ryu 2009                       | Molar                | hDPSCs    |                       |     |                                 |              |         |                                                              |
| Sakai 2012                     | Third molar          | DPSCs     | 18-30 y               |     |                                 |              |         |                                                              |
| Schiraldi 2012                 | Third molar          | DPSCs     | 21-45 y               |     |                                 |              |         |                                                              |
| Seifrtova 2012                 | Impacted third molar | DPSCs     |                       |     |                                 |              |         |                                                              |
| Seifrtova 2013                 | Impacted third molar | DPSCs     |                       |     |                                 |              |         |                                                              |
| Seo 2013                       | Impacted third molar | DPSCs     | 20-28 y               |     | Cleaned (not described)         |              |         | Cut around CEJ by using sterilized diamond stones             |
| Shafiei 2014                   | Third molar          | DPSCs     | 20-25 y               |     |                                 |              |         | Cut around CEJ by using fissure bur                          |
| Shekar 2012                    | Impacted third molar | DPSCs     |                       |     | α-MEM supplemented with antibiotics: 100 IU penicillin, 100 µg/mL streptomycin, pH 7.27.4 | Immediately |         | Washing with DPBS and Chisel and mallet Forceps and a spoon excavator (2 mm diameter) |

(Contd...)
| Author and year of publication | Tooth                     | Cell type | Age at the extraction | Sex | Storage method for transporting | Storage time | Hygiene                      | Methods section of tooth | Methods for removing the pulp from the interior of the chamber |
|--------------------------------|---------------------------|-----------|-----------------------|-----|--------------------------------|--------------|-------------------------------|--------------------------|---------------------------------------------------------------|
| Shi 2002                       | Impacted third molar      | DPSCs     |                       |     |                                |              |                               |                          | Gracey curette                                                    |
| Solazzo 2011                   | Third molar               | DPSCs     | 20-25 y               |     |                                |              | Cleaned (not described)       | Cut around JEC by using sterilized dental fissure bur          |                                |
| Son 2006                       | Molar                     | hDPSCs    |                       |     |                                |              |                               |                          |                                |
| Spath 2010                     | Third molar               | DPSCs     | 22-35 y               |     |                                |              | Treatment one week before extraction with professional dental hygiene. Before extraction, dental crowns were covered with a 0.3% CHX gel (Forhans, NY, USA) for 2 min | Dentinal excavator or a gracey curette |                                |
| Stevens 2008                   | Premolar                  | hDPSCs    |                       |     |                                |              |                               |                          |                                |
| Stokowski 2007                 | Impacted third molar      | DPSCs     | 18-40 y               |     |                                |              | Cleaned (not described)       | Vise                     |                                |
| Struys 2013                    | Third molar               | DPSCs     | 16-19 y               |     |                                |              | Fractured mechanically        | Forceps                  |                                |
| Struys 2011                    | Third molar               | DPSCs     | Fractured mechanically |     |                                |              | Fractured mechanically        | Forceps                  |                                |
| Suchanek 2013                  | Semi-erupted third molar  | DPSCs     | 23 y                  | Male| HBSS (Gibco, UK)               | Immediately | Luer’s forceps                | Extirpation needle or tweezers                                |                                |
|                                | Third molar               |           | 22 y                  | Female|                                |              |                               |                          |                                |
**How has Tooth Manipulation been Conducted for Dental Pulp Stem Cells Isolation? A Scoping Review**

| Author and year of publication | Tooth                          | Cell type | Age at the extraction | Sex | Storage method for transporting | Storage time | Hygiene | Methods section of tooth | Methods for removing the pulp from the interior of the chamber |
|--------------------------------|--------------------------------|-----------|-----------------------|-----|--------------------------------|--------------|---------|--------------------------|---------------------------------------------------------------|
| Suchanek 2007                  | Impacted third molar           | DPSCs     | 15-23 y               |     | HBSS (Gibco, Scotland)         | Immediately |         | Skive or luer’s Forceps  | Excavator (Henry Schein Inc., UK) and sharp needle             |
| Suchanek 2009                  | Third molar                    | DPSCs     | 12-23 y               | Male Female | HBSS (Gibco, Scotland)         | Immediately |         | Luer’s Forceps           | Extirpation needle or sharp excavator (Henry Schein, UK)       |
| Suh 2014                       | Third molar                    | DPSCs     | 19-40 y               |     |                                 |              |         | Cut around CEJ by using sterilized dental fissure bur |                                                        |
| Suri 2008                      | Premolar                       | HDPCs     |                       |     |                                 |              |         | Chisel and mallet        | Sterile spoon excavator and tweezers                           |
| Suzyki 2011                    | Third molar                    | DSCs      | 14 y                  | Male |                                 |              |         | Cut around CEJ by using sterilized dental fissure bur |                                                        |
| Tamaki 2013                    | Third molar                    | DPSCs     | 16-28 y               | Female |                                 |              |         | Forceps                  |                                                        |
| Tammaro 2014                   | Impacted third molar           | hDPSCs    | 18-22 y               |     |                                 | 30 min       | Rinse with 0.2% CHX for 60 sec | Barbed broach                                                |
| Tandon 2010                    | Premolar                       | DPSCs     |                       |     |                                 |              |         | Treatment with professional dental hygiene. The dental crown is covered with 0.3% CHX gel for 2 min (Forhans) | Dentinal excavator or a gracey curette                      |
| Tirino 2012                    | Third molar                    | DPSCs     |                       |     |                                 |              |         |                          | (Contd...)                                                     |
| Author and year of publication | Tooth | Cell type | Age at the extraction | Sex | Storage method for transporting | Storage time | Hygiene | Methods section of tooth | Methods for removing the pulp from the interior of the chamber |
|-------------------------------|-------|-----------|------------------------|-----|---------------------------------|-------------|--------|-------------------------|-----------------------------------------------|
| Tomic 2011                   | Third molar | DP-MSCs | | | Serum-free culture medium | Immediately | | | |
| Tom-Kun 2011                 | Premolar | hDPSCs | | | Pretreatment for a week with professional dental hygiene. Rinsed four times in PBS containing penicillin and streptomycin. | | | Sterile dentinal excavator | |
| Trubiani 2010                | Premolar | DP-MSCs | | | Pretreatment for a week with professional dental hygiene. Rinsed four times in PBS containing penicillin and streptomycin. | | Sterile dentinal excavator | Cylindrical diamond bur (Intensiv, Grancia, Switzerland) mounted on a high-speed handpiece (Bora L; Bien-Air, Biene, Switzerland) with water-spray cooling |
| Trubiani 2012                | Premolar | | | | | | | Sterile dentinal excavator | Cylindrical diamond bur (Intensiv, Grancia, Switzerland) mounted on a high-speed handpiece (Bora L; Bien-Air, Biene, Switzerland) with water-spray cooling |
| Trubiani 2007                | | | 24-30 y | | Rinsed four times in PBS containing penicillin and streptomycin | | | | |
| Uchiyama 2009                | Third molar | DPSCs | 37 and 42 y | Female | | | | | |
| Um 2011                      | Third molar | DPSCs | 20-24 y | Male | | | | | |
| Vandomme 2014                | Third molar | DPSCs | | | | | | | |
| Author and year of publication | Tooth | Cell type | Age at the extraction | Sex | Storage method for transporting | Storage time | Hygiene | Methods of tooth section for removing the pulp from the interior of the chamber | Methods section of tooth |
|-------------------------------|-------|-----------|------------------------|-----|-----------------------------|-------------|---------|--------------------------------|------------------------|
| Varga 2011                   | Premolar | hDPSCs    | Mean of 27 y          | Male| Sterile physiologic saline with gentamicin (Lék, Slovenia) | Immediately | Rinsed with PBS (Oxoid, GB) | Cut around CEJ by using Luer's forceps | Excavator |
| Vasandan 2014                | Impacted third molar | DPSCs   | 17-28 y               | Female| Washed with DPBS (Gibco, Grand Island, NY, USA) containing AA | Dehydrated | Bone forceps | |
| Ventura 2007                 | Molar | DPhMSCs   |                        |      | Immersion in physiological solution containing antibiotics | Immediatly | Cleaned (not described) | Sterilized dental bur | Small size broach and blunt non cutting forceps |
| Vishwanath 2013              | DPSCs | Less than 25 y | FBS                   | Immediately | Cleaned (not described) | Sterilized dental bur | Small size broach and blunt non cutting forceps |
| Wada 2009                    | Premolar | DPSCs   |                        |      |                        |                     |                     |                     |
| Wang 2010                    | Third molar | DPSCs | 15-25 y               |      |                        |                     |                     |                     |
| Wang 2014                    | Impacted third molar | hDPSCs | 19-28 y               |      |                        |                     |                     |                     |
| Wang 2012                    | First premolar | DPSCs | 18-20 y               |      |                        |                     |                     |                     |
| Wang 2013 (a)                | DPSCs | 14-25 y   |                        |      |                        |                     |                     |                     |
| Wang 2013 (b)                | Premolar | DPSCs | 12-13 y               |      |                        |                     |                     |                     |
| Author and year of publication | Tooth | Cell type | Age at the extraction | Sex | Storage method for transporting | Storage time | Hygiene | Methods for removing the pulp from the interior of the chamber |
|-------------------------------|-------|-----------|-----------------------|-----|-------------------------------|-------------|---------|------------------------------------------------------------|
| Weszl 2012                    | Impacted third molar | DPSCs | 18-26 y | | | | | Cut around CEJ by using sterile dental fissure bur |
| Woods 2009                    | Third molar | DPSCs | 15-30 y | | PBS (Sigma Chemical, St. Louis, MO) | 24 h | Washed with sterile saline, exposure to 1% PVP-I for 2 min, 0.1% sodium thiosulfate in PBS for 1 min and another wash in sterile PBS. Immersion in Listerine antiseptic (Johnson and Johnson Healthcare Products, Langhorne, PA) for 1 min, followed by several final washes in sterile PBS. | Curette |
| Yan 2010                      | DPSCs | | | | | | | |

(Contd...)
## How has Tooth Manipulation been Conducted for Dental Pulp Stem Cells Isolation? A Scoping Review

| Author and year of publication | Tooth                | Cell type | Age at the extraction | Sex     | Storage method for transporting | Storage time | Hygiene | Methods section of tooth | Methods for removing the pulp from the interior of the chamber |
|--------------------------------|----------------------|-----------|-----------------------|---------|-------------------------------|--------------|---------|--------------------------|---------------------------------------------------------------|
| Yu 2009                        | Premolar             | DPSCs     |                       |         | Cleaned with dental soaler to remove attached soft tissue |              |         |                          | Splitting the teeth at the CEJ sterile dental drill            |
| Zhai 2013                      | First premolar       | hDPSCs    |                       |         |                               |              |         |                          |                                                              |
| Zhang 2011                     | Third molar          | DPSCs     | 16 y                  | Female  |                               |              |         |                          | Vise                                                          |
| Zhang 2010                     | Third molar          | DMCs      | 16 y                  | Male    |                               |              |         |                          |                                                              |
| Zhang 2006                     | Impacted third molar | DPSCs     | 18-24 y               |         | α-MEM (Gibco BRL, Life Technologies B.V. Breda, The Netherlands), 0.5 mg/mL of gentamicin (Gibco BRL), 3mg/mL amphotericin B (Gibco BRL) |              | Cleaned (not described) | Cut around the CEJ by using a high-speed dental drill          |
| Zhang 2008 (a)                 | Impacted third molar | DPSCs     | 22 y                  | Male    |                               |              |         |                          |                                                              |
| Zhang 2008 (b)                 | Impacted third molar | DPSCs     | 22 y                  | Male    |                               |              |         |                          |                                                              |
| Zhao 2011                      | Third molar          | hDPSCs    | 18-35 y               | Male    |                               |              |         |                          |                                                              |
| Zhao 2006                      | Lower premolar       | hDPSCs    |                       |         |                               |              |         |                          |                                                              |
| Zhou 2014                      | Impacted third molar | DPCs      | 18-30 y               |         |                               |              |         |                          |                                                              |
1. Abdullah, M.F., et al., 2014. Proliferation rate of stem cells derived from human dental pulp and identification of differentially expressed genes. Cell Biol. Int. 38, 582-590.

2. Abu Kasim, N.H., et al., 2012. Unique molecular signatures influencing the biological function and fate of post-natal stem cells isolated from different sources. J. Tissue Eng. Regen. Med. 9, 252-266.

3. Agha-Hosseini, F., et al., 2010. In vitro isolation of stem cells derived from human dental pulp. Clin Transplant. 24, 23-28.

4. Ahmed N.E.M.B., et al., 2011. Isolation of dental pulp stem cells and their in vitro differentiation into odontoblast-like cells. Macedonian Journal of Medical Sciences. 4, 253-260.

5. Akkouch, A., et al., 2014. Engineering bone tissue using human dental pulp stem cells and an osteogenic collagen-hydroxyapatite-poly (L-lactide-co-epsilon-caprolactone) scaffold. J Biomater Appl. 28, 922-936.

6. Al-Habib, M., et al., 2012. Small molecules affect human dental pulp stem cell properties via multiple signaling pathways. Stem Cells Dev. 22, 2402-2413.

7. Alongi, D.J., et al., 2010. Stem/progenitor cells from inflamed human dental pulp retain tissue regeneration potential. Regen Med. 5, 617-631.

8. Arminan, A., et al., 2009 Cardiac differentiation is driven by NKX2.5 and GATA4 nuclear translocation in tissue-specific mesenchymal stem cells. Stem Cells Dev. 18, 907-918.

9. Arthur, A., et al., 2008. Adult human dental pulp stem cells differentiate toward functionally active neurons under appropriate environmental cues. Stem Cells. 26, 1787-1795.

10. Asgary, S., et al., 2014. Gene expression and cytokine release during odontogenic differentiation of human dental pulp stem cells induced by 2 endodontic biomaterials. J Endod. 40, 387-392.

11. Atari, M., et al., 2011. Isolation of pluripotent stem cells from human third molar dental pulp. Histol Histopathol. 26, 1057-1070.

12. Atari, M., et al., 2012. The enhancement of osteogenesis through the use of dental pulp pluripotent stem cells in 3D. Bone. 50, 930-941.

13. Atari, M., et al., 2012. Dental pulp of the third molar: a new source of pluripotent-like stem cells. J Cell Sci. 125, 3343-3356.

14. Attar, A., et al., 2014. Dental pulp polyps contain stem cells comparable to the normal dental pulps. J Clin Exp Dent. 6, 53-59.

15. Bakopoulou, A., et al., 2011. Comparative analysis of in vitro osteo/odontogenic differentiation potential of human dental pulp stem cells (DPSCs) and stem cells from the apical papilla (SCAP). Arch Oral Biol. 56, 709-721.

16. Batouli, S., et al., 2003 Comparison of stem-cell-mediated osteogenesis and dentinogenesis. J Dent Res. 82, 976-981.

17. Bonnemann, V., et al., 2013. Human dental pulp stem cells cultured in serum-free supplemented medium. Front Physiol. 4:1-9.

18. Bressan, E., et al., 2012. Donor age-related biological properties of human dental pulp stem cells change in nanostructured scaffolds. PLoS One. 7, 1-12.

19. Cai, X., et al., 2011. Uniaxial cyclic tensile stretch inhibits osteogenic and odontogenic differentiation of human dental pulp stem cells. J Tissue Eng Regen Med. 5, 347-353.

20. Carinci, F., et al., 2008. Comparison between genetic portraits of osteoblasts derived from primary cultures and osteoblasts obtained from human pulpar stem cells. J Craniofac Surg. 19, 616-625.

21. Carvalho, A., et al., 2012. Micropatterned silica thin films with nanohydroxyapatite micro-aggregates for guided tissue regeneration. Dent Mater. 28, 1250-1260.

22. Chen, Y.K., et al., 2013. Human dental pulp stem cells derived from cryopreserved dental pulp tissues of vital extracted teeth with disease demonstrate hepatic-like differentiation. J Tissue Eng Regen Med. 10, 6, 475-485.

23. Chen, B., et al., 2012. The effects of human platelet lysate on dental pulp stem cells derived from impacted human third molars. Biomaterials33, 5023-5035.

24. Chen, Y.K., et al., 2011. Human dental pulp stem cells derived from different cryopreservation methods of human dental pulp tissues of diseased teeth. J Oral Pathol Med. 40, 793-800.

25. Choi, Y.J., et al., 2012. Cell-penetrating superoxide dismutase attenuates oxidative stress-induced senescence by regulating the p53-p21(Cip1) pathway and restores osteoblastic differentiation in human dental pulp stem cells. Int J Nanomedicine. 7, 5091-106.

26. Chun, S.Y., et al., 2011. Composite Scaffold with Demineralized Dentin Particle and Poly(Lactic Co-Glycolic Acid) for Cranial Bone Regeneration. Tissue Engineering and Regenerative Medicine. 8, 306-313.

27. Chun, S.Y., et al., 20011. Analysis of the soluble human tooth proteome and its ability to induce dentin/tooth regeneration. Tissue Eng Part A. 17, 181-191.

28. Cmielova, J., et al., 2013. The effect of ATM kinase inhibition on the initial response of human dental pulp and periodontal ligament mesenchymal stem cells to ionizing radiation. Int J Radiat Biol. 89, 501-511.

29. Collart-Dutilleul, P.Y., et al., 2014. Adhesion and proliferation of human mesenchymal stem cells from dental pulp on porous silicon scaffolds. ACS Appl Mater Interfaces. 6, 1719-1728.

30. Cui, L., et al., 2014. The role of integrin-alpha5 in the proliferation and odontogenic differentiation of human dental pulp stem cells. J Endod. 40, 235-240.

31. Cui, L., et al., 2013. The effect of TRPM7 suppression on the proliferation, migration and osteogenic differentiation of human dental pulp stem cells. Int Endod J. 47, 6, 583-593.

32. Dai, J., et al., 2012. The effect of co-culturing costal chondrocytes and dental pulp stem cells combined with exogenous FGF9 protein on chondrogenesis and ossification in engineered cartilage. Biomaterials. 33, 7699-7711.

33. D’Alimonte, I., et al., 2013. Adenosine A(1) receptor stimulation enhances osteogenic differentiation of human dental pulp-derived mesenchymal stem cells via WNT signaling. Stem Cell Research. 11, 611-624.

34. D’Alimonte, I., et al., 2011. Vascular Endothelial Growth Factor Enhances In Vitro Proliferation and Osteogenic Differentiation of Human Dental Pulp Stem Cells. Journal of Biological Regulators and Homeostatic Agents. 25, 57-69.

35. d’Aquino, R., et al., 2009. Human mandible bone defect repair by the grafting of dental pulp stem/progenitor cells and collagen sponge biocomplexes. Eur Cell Mater. 18, 75-83.

36. d’Aquino, R., et al., 2007. Human postnatal dental pulp cells co-differentiate into osteoblasts and endotheliocytes: a pivotal synergy leading to adult bone tissue formation. Cell Death Differ. 14, 1162-1171.

37. De Rosa, A.,et al., 2011. Amniotic fluid-derived mesenchymal stem cells from the apical papilla. Stem Cells Dev. 20, 40, 387-932.

38. de Souza, L.M., et al., 2010. Comparative isolation protocols and characterization of stem cells from human primary and permanent teeth pulp. Brazilian Journal of Oral Sciences. 9, 427-433.
How has Tooth Manipulation been Conducted for Dental Pulp Stem Cells Isolation? A Scoping Review

39. Demircan, P.C., et al., 2011. Immunoregulatory effects of human dental pulp-derived stem cells on T cells: comparison of transwell co-culture and mixed lymphocyte reaction systems. Cytotherapy. 13, 1205-1220.
40. Diomedes, F., et al., 2013. Pro-inflammatory cytokine release and cell growth inhibition in primary human oral cells after exposure to endodontic sealer. Int Endod J. 47, 9, 864-872.
41. Dissanayaka, W.L., et al., 2012. Coculture of dental pulp stem cells with endothelial cells enhances osteo-/odontogenic and angiogenic potential in vitro. J Endod. 38, 454-463.
42. Dissanayaka, W. L., et al., 2011. Characterization of dental pulp stem cells isolated from canine premolars. J Endod. 37, 1074-80.
43. Djouad, F., et al., 2010. Activin A expression regulates multipotency of mesenchymal progenitor cells. Stem Cell Res Ther. 1, 11.
44. Dolatshahi-Pirouz, A., et al., 2010. Fibronectin adsorption, cell adhesion, and proliferation on nanostructured tantalum surfaces. ACS Nano. 4, 2874-2882.
45. Duailibi, M.T., et al., 2011. Tooth tissue engineering: optimal dental stem cell harvest based on tooth development. Artif Organs. 35, 129-135.
46. Ebrahimi, B., et al., 2011. Human dental pulp stem cells express many pluripotency regulators and differentiate into neuronal cells. Neural Regeneration Research. 6, 2666-2672.
47. Egubunwe, O., et al., 2011. P16/p53 expression and telomerase activity in immortalized human dental pulp cells. Cell Cycle. 10, 3912-3919.
48. Eleuterio, E., et al., 2013. Proteome of human stem cells from periodontal ligament and dental pulp. PLoS One. 8, 1-12.
49. Eslaminejad, M.B., et al., 2013. Odontogenic differentiation of dental pulp-derived stem cells on tricalcium phosphate scaffolds. Journal of Dental Sciences. 8, 306-313.
50. Elawady, M.B., et al., 2010. Isolation and in vitro Characterization of Mesenchymal Stem Cells Derived from the Pulp Tissue of Human Third Molar Tooth Iranian Journal of Medical Sciences. 35, 216-225.
51. Elawady, M.B., et al., 2010. In vitro Growth and Characterization of Stem Cells from Human Dental Pulp of Deciduous Versus Permanent Teeth. J Dent (Tehran). 7, 185-95.
52. Elawady, M.R.B., et al., 2009. Human Dental Pulp Stem Cells: The Culture Optimization for Increased Growth International Journal of Hematology-Oncology and Stem Cell Research. 3, 5-13.
53. Eubanks, E.J., et al., 2014. Tooth storage, dental pulp stem cell isolation, and clinical scale expansion without animal serum. Journal of Endodontics. 40, 5, 652-657.
54. Fang, C.Z., et al., 2013. Intraventricular injection of human dental pulp stem cells improves hypoxic-ischemic brain damage in neonatal rats. PLoS One. 8, 1-7.
55. Feng, X., et al., 2014. Repeated lipopolysaccharide stimulation promotes cellular senescence in human dental pulp stem cells (DPSCs). Cell Tissue Res. 356, 2, 369-380.
56. Feng, X., et al., 2013. TNF-alpha triggers osteogenic differentiation of human dental pulp stem cells via the NF-kappaB signalling pathway. Cell Biol Int. 37, 1267-1275.
57. Feng, X., et al., 2013. Age-dependent impaired neurogenic differentiation capacity of dental stem cell is associated with Wnt/beta-catenin signaling. Cell Mol Neurobiol. 33, 1023-1031.
58. Foudah, D., et al., 2014. Expression of Neural Markers by Undifferentiated Mesenchymal-Like Stem Cells from Different Sources. Journal of Immunology Research. 2014, 1-16.
59. Gabanyi, L., et al., 2013. VP22 herpes simplex virus protein can transduce proteins into stem cells. Braz J Med Biol Res. 46, 121-7.
60. Gandia, C., et al., 2008. Human dental pulp stem cells improve left ventricular function, induce angiogenesis, and reduce infarct size in rats with acute myocardial infarction. Stem Cells. 26, 638-645.
61. Gay, L., et al., 2014. Differentiation of human dental stem cells reveals a role for microRNA-218. J Periodontal Res. 49, 110-120.
62. Giorgini, E., et al., 2011. FT-IR microscopic analysis on human dental pulp stem cells. Vibrational Spectroscopy. 57, 30-34.
63. Govindasamy, V., et al., 2011. Human platelet lysate permits scale-up of dental pulp stromal cells for clinical applications. Cytotherapy. 13, 1221-1233.
64. Govindasamy, V., et al., 2010. Inherent differential propensity of dental pulp stem cells derived from human deciduous and permanent teeth. J Endod. 36, 1504-1515.
65. Govindasamy, V., et al., 2010. Micromanipulation of culture niche permits long-term expansion of dental pulp stem cells-an economic and commercial angle. In Vitro Cellular & Developmental Biology-Animal. 46, 764-773.
66. Graziano, A., et al., 2008. Scaffold's surface geometry significantly affects human stem cell bone tissue engineering. Journal of Cellular Physiology. 214, 166-172.
67. Graziano, A., et al., 2007. Concave pit-containing scaffold surfaces improve stem cell-derived osteoblast performance and lead to significant bone tissue formation. PLoS One. 2, 1-9.
68. Grothos, S., et al., 2000. Postnatal human dental pulp stem cells (DPSCs) in vitro and in vivo. Proc Natl Acad Sci U S A. 97, 13625-13630.
69. Han, M-J., et al., 2010. Upregulation of Bone-like Extracellular Matrix Expression in Human Dental Pulp Stem Cells by Mechanical Strain. Biotechnology and Bioprocess Engineering. 15, 572-579.
70. Han, M-J., et al., 2008. Effect of mechanical tension on the human dental pulp cells. Biotechnology and Bioprocess Engineering. 13, 410-417.
71. Havelek, R., et al., 2013. Ionizing radiation induces senescence and differentiation of human dental pulp stem cells. Folia Biol (Praha). 59, 188-197.
72. He, W., et al., 2014. Lipopolysaccharide enhances Wnt5a expression through toll-like receptor 4, myeloid differentiating factor 88, phosphatidylinositol 3-OH kinase/AKT and nuclear factor kappa B pathways in human dental pulp stem cells. J Endod. 40, 69-75.
73. He, W., et al., 2013. LPS induces IL-8 expression through TLR4, MyD88, NF-kappaB and MAPK pathways in human dental pulp stem cells. Int Endod J. 46,128-136.
74. He, H., et al., 2008. Effects of FGFR2 and TGFbeta1 on the differentiation of human dental pulp stem cells in vitro. Cell Biol Int. 32, 827-834.
75. Hilkens, P., et al., 2013. Effect of isolation methodology on stem cell properties and multilineage differentiation potential of human dental pulp stem cells. Cell Tissue Res. 353, 65-78.
76. Hirata, T. M., et al., 2010. Expression of multiple stem cell markers in dental pulp cells cultured in serum-free media. J Endod. 36, 1139-1144.
77. Hoss, M., et al., 2013. Integrin alpha4 impacts on differential adhesion of preepidycytes and stem cells on synthetic polymers. J Tissue Eng Regen Med. 7, 312-323.
78. Huang, C.H., et al., 2010. Glucosamine promotes osteogenic differentiation of dental pulp stem cells through modulating the level of the transforming growth factor-beta type I receptor. J Cell Physiol. 225, 140-51.

79. Huang, G.T., et al., 2010. Stem/progenitor cell-mediated de novo regeneration of dental pulp with newly deposited continuous layer of dentin in an in vivo model. Tissue Eng Part A.16, 605-615.

80. Huang, A.H., et al., 2009. Chen YK, Chan AW, Shieh TY, Lin LM. Isolation and characterization of human dental pulp stem/stromal cells from nonextracted crown-fractured teeth requiring root canal therapy. J Endod. 35, 673-681.

81. Huang, A.H., et al., 2008. Isolation and characterization of dental pulp stem cells from a supernumerary tooth. J Oral Pathol Med. 37, 571-574.

82. Ishkitiev, N., et al., 2012. High-purity hepatic lineage differentiated from dental pulp stem cells in serum-free medium. J Endod. 38, 475-480.

83. Ishkitiev, N., et al., 2010. Deciduous and Permanent Dental Pulp Mesenchymal Cells Acquire Hepatic Morphologic and Functional Features In Vitro. Journal of Endodontics. 36, 469-474.

84. Jeon, B.G., et al., 2011. Comparative analysis of telomere length, telomerase and reverse transcriptase activity in human dental stem cells. Cell Transplant. 20, 1693-1705.

85. Jin, H., et al., 2013. HDAC inhibitor trichostatin A promotes proliferation and odontoblast differentiation of human dental pulp stem cells. Tissue Eng Part A. 19, 613-24.

86. Kadar, K., et al., 2009. Differentiation potential of stem cells from human dental origin - promise for tissue engineering. J Physiol Pharmacol. 60, 167-75.

87. Kanafi, M., et al., 2014. Midbrain Cues Dictate Differentiation of Human Dental Pulp Stem Cells Towards Functional Dopaminergic Neurons. J Cell Physiol. 229, 1369-1377.

88. Kanafi, M.M., et al., 2013. Phenotypic and functional comparison of optimum culture conditions for upscaling of dental pulp stem cells. Cell Biol Int. 37, 126-136.

89. Kanafi, M.M., et al., 2013. Transplantation of islet-like cell clusters derived from human dental pulp stem cells restores normoglycemia in diabetic mice. Cytotherapy. 15, 1228-1236.

90. Kanafi, M.M., et al., 2013. Influence of hyposxia, high glucose, and low serum on the growth kinetics of mesenchymal stem cells from deciduous and permanent teeth. Cells, tissues, organs. 198,198-208.

91. Kanafi, M.M., et al., 2013. Dental pulp stem cells immobilized in alginate microspheres for applications in bone tissue engineering. Int Endod J. 47, 687-697.

92. Koyama, N., et al., 2009. Evaluation of pluripotency in human dental pulp cells. J Oral Maxillofac Surg. 67, 501-506.

93. Kraft, D.C., et al., 2010. The role of asporin in mineralization of human dental stem cells derived from human umbilical cord blood. J Craniofac Surg. 17, 511-515.

94. Krafft, D.C., et al., 2010. Mechano sensitivity of dental pulp stem cells is related to their osteogenic maturity. Eur J Oral Sci. 118, 29-38.

95. Laino, G., et al., 2006. In vitro bone production using stem cells derived from human dental pulp. J Craniofac Surg. 17, 511-515.

96. Laino, G., et al., 2005. A new population of human adult dental pulp stem cells: a useful source of living autologous fibrous bone tissue (LAB). J Bone Miner Res. 20, 1394-1402.

97. Lee, S.Y., et al., 2012. Magnetic cryopreservation for dental pulp stem cells. Cells, tissues, organs. 196, 23-33.

98. Lee, E.H., et al., 2011. The role of aspirin in mineralization of human dental pulp stem cells. J Cell Physiol. 226, 1676-1682.

99. Lee, J.H., et al., 2011. Odontogenic differentiation of human dental pulp stem cells induced by preameloblast-derived factors. Biomaterials. 32, 9696-9706.

100. Lee, J.Y., et al., 2011. The effects of platelet-rich plasma derived from human umbilical cord blood on the osteogenic differentiation of human dental stem cells. In Vitro Cell Dev Biol Anim. 47, 157-164.

101. Lee, U.L., et al., 2011. Effect of platelet-rich plasma on dental stem cells derived from human impacted third molars. Regener Med. 6, 67-79.

102. Lee, S.H., et al., 2010. Comparison of ganglioside expression between human adipose- and dental pulp-derived stem cell differentiation into osteoblasts. Arch Pharm Res. 33, 585-591.

103. Lee, S.H., et al., 2010. Culture of Mesenchymal Stromal Cells from Dental Pulp: Culture Medium Study for Effective Expansion and Characterization. Tissue Engineering and Regenerative Medicine. 7, 248-254.

104. Lee, S.Y., et al., 2010. Effects of cryopreservation of intact teeth on the isolated dental pulp stem cells. J Endod. 36, 1336-1340.

105. Lee, E.H., et al., 2011. Comparison of ganglioside expression between human adipose- and dental pulp-derived stem cell differentiation into osteoblasts. Arch Pharm Res. 33, 585-591.

106. Lee, S.H., et al., 2010. Culture of Mesenchymal Stromal Cells from Dental Pulp: Culture Medium Study for Effective Expansion and Characterization. Tissue Engineering and Regenerative Medicine. 7, 248-254.

107. Lee, S.Y., et al., 2010. Effects of cryopreservation of intact teeth on the isolated dental pulp stem cells. J Endod. 36, 1336-1340.

108. Lee, E.H., et al., 2011. Odontogenic differentiation of human dental pulp stem cells induced by preameloblast-derived factors. Biomaterials. 32, 9696-9706.

109. Lee, L.M. Isolation and characterization of human dental pulp stem cells derived from dental tissues and bone marrow. J Periodontal Implant Sci. 41, 192-200.

110. Kiraly, M., et al., 2011. Integration of neuronally predifferentiated human dental pulp stem cells into rat brain in vivo. Neurochem Int. 59, 371-381.

111. Kiraly, M., et al., 2009. Simultaneous PKC and cAMP activation induces differentiation of human dental pulp stem cells into functionally active neurons. Neurochem Int. 55, 323-332.
117. Li, J.H., et al., 2011. Human dental pulp stem cell is a promising autologous seed cell for bone tissue engineering. Chin Med J (Engl). 124, 4022-4028.

118. Lin, C.Y., et al., 2011. Zinc chloride for odontogenesis of dental pulp stem cells via metallothionein up-regulation. J Endod. 37, 211-216.

119. Lindroos, B., et al., 2008. Characterisation of human dental stem cells and buccal mucosa fibroblasts. Biochemical and Biophysical Research Communications. 368, 329-335.

120. Liu, H., et al., 2004. Dentin, a fragment of MEPE, enhanced dental pulp stem cell proliferation. J Dent Res. 83, 496-499.

121. Luo, Z., et al., 2014. Biodentine induces human dental pulp stem cell differentiation through mitogen-activated protein kinase and calcium-/calmodulin-dependent protein kinase II pathways. Journal of Endodontics. 40, 937-942.

122. Luo, Z., et al., 2014. Effect of Biodentine on the proliferation, migration and adhesion of human dental pulp stem cells. J Dent. 42, 490-497.

123. Ma, D., et al., 2012. Changes in proliferation and osteogenic differentiation of stem cells from deep caries in vitro. J Endod. 38, 796-802.

124. Makino, Y., et al., 2013. Immune therapeutic potential of stem cells from human supernumerary teeth. J Dent Res. 92, 609-615.

125. Mangano, C., et al., 2010. Human dental pulp stem cells hook into biocoral scaffold forming an engineered biocomplex. PLoS One. 6, 1-9.

126. Mangano, C., et al., 2010. The osteoblastic differentiation of dental pulp stem cells and bone formation on different titanium surface textures. Biomaterials. 31, 3543-3551.

127. Manikandhan, R., et al., 2010. Successful isolation, in vitro expansion and characterization of stem cells from Human Dental Pulp. J Stem Cells Regen Med. 6, 168-169.

128. Marchionni, C., et al., 2009. Angiogenic potential of human dental pulp stromal (stem) cells. Int J Immunopathol Pharmacol. 22, 699-706.

129. Martens, W., et al., 2012. Expression pattern of basal markers in human dental pulp stem cells and tissue. Cells, tissues, organs. 196, 490-500.

130. Martin-Piedra, M.A., et al., 2013. Average cell viability levels of human dental pulp stem cells: an accurate combinatorial index for quality control in tissue engineering. Cytotherapy, 15, 507-518.

131. Min, J. H., et al., 2011. Dentinogenic potential of human adult dental pulp cells during the extended primary culture. Hum Cell. 24, 43-50.

132. Mokry, J., et al. 2010. Telomere attrition occurs during ex vivo expansion of human dental pulp stem cells. J Biomed Biotechnol. 2010, 1-11.

133. Mori, G., et al., 2011. Dental pulp stem cells: osteogenic differentiation and gene expression. Ann N Y Acad Sci. 1237, 47-52.

134. Murakami, M., et al., 2013. The use of granulocyte-colony stimulating factor induced mobilization for isolation of dental pulp stem cells with high regenerative potential. Biomaterials. 34, 9036-9047.

135. Murakami, M., et al., 2012. Identification of novel function of vimentin for quality standard for regenerated pulp tissue. J Endod. 38, 920-926.

136. Muthna, D., et al., 2010. Irradiation of adult human dental pulp stem cells provokes activation of p53, cell cycle arrest, and senescence but not apoptosis. Stem Cells Dev. 19, 1855-1862.

137. Nadeem, D., et al., 2013. Fabrication and in vitro evaluation of a sponge-like bioactive-glass/gelatin composite scaffold for bone tissue engineering. Mater Sci Eng C. Mater Biol Appl. 33, 2669-2678.

138. Nakamura, S., et al., 2009. Stem cell proliferation pathways comparison between human exfoliated deciduous teeth and dental pulp stem cells by gene expression profile from promising dental pulp. J Endod. 35, 1536-1542.

139. Nam, S., et al., 2011. Odontogenic differentiation of human dental pulp stem cells stimulated by the calcium phosphate porous granules. J Tissue Eng. 2011, 1-10.

140. Navabazam, A.R., et al., 2013. Characterization of mesenchymal stem cells from human dental pulp, preapical follicle and periodontal ligament. Iranian Journal of Reproductive Medicine. 11, 235-242.

141. Mat Nawi NSB, Ariffin Z, Alam MK, Mohd Noor SNF, Hassan A. International Medical Journal. 2013;20:593-6.

142. Nesti, C., et al., 2011. Human dental pulp stem cells protect mouse dopaminergic neurons against MPP+ or rotenone. Brain Res. 1367, 94-102.

143. Neuss, S., et al., 2008. Assessment of stem cell/biomaterial combinations for stem cell-based tissue engineering. Biomaterials. 29, 302-313.

144. Niu, L.N., et al., 2014. Intrafibrillar-silicified collagen scaffolds enhance the osteogenic capacity of human dental pulp stem cells. J Dent. 42, 839-849.

145. Oancea, R., et al., 2013. Behavioural Changes and Plastic Potential Alteration of Dental Pulp Stem Cells Exposed to High Glucose Concentrations. Digest Journal of Nanomaterials and Biоструктуры. 8, 313-321.

146. Okamoto, Y., et al., 2009. Simvastatin induces the odontogenic differentiation of human dental pulp stem cells in vitro and in vivo. J Endod. 35, 367-372.

147. Osathanon, T., et al., 2014. Neurogenic differentiation of human dental pulp stem cells using different induction protocols. Oral Dis. 20, 352-358.

148. Osathanon, T., Nowwarote, N., Pavanast, P., 2011. Basic fibroblast growth factor inhibits mineralization but induces neuronal differentiation by human dental pulp stem cells through a FGFβ and PLCγ2 K signal pathway. J Cell Biochem. 112, 1807-1816.

149. Paine, F., et al., 2010. Ecto-mesenchymal stem cells from dental pulp are committed to differentiate into active melanocytes. Eur Cell Mater. 20, 295-305.

150. Palumbo, C., et al., 2013. Immunocytochemical and structural comparative study of committed versus multipotent stem cells cultured with different biomaterials. Micron. 47, 1-9.

151. Pang, N.S., et al., 2014. Effect of EDTA on attachment and differentiation of dental pulp stem cells. J Endodontics. 40, 811-817.

152. Papaccio, G., et al. 2006. Long-term cryopreservation of dental pulp stem cells (SBP-DPSCs) and their differentiated osteoblasts: a cell source for tissue repair. J Cell Physiol. 208, 319-325.

153. Park, J-Y., et al., 2013. Comparative analysis of mesenchymal stem cell surface marker expression for human dental mesenchymal stem cells. Regenerative Medicine. 8, 453-466.

154. Patil, R., et al., 2014. Multilineage potential and proteomic profiling of human dental stem cells derived from a single donor. Exp Cell Res. 320, 92-107.

155. Pereira, L.O., Figueiro, L.J.P., Azevedo, R.B., 2012. Laser irradiation did not increase the proliferation or the donor.

156. Pereira, L.O., et al. 2012. Comparison of stem cell properties of cells isolated from normal and inflamed dental pulps. Int Endod J. 45, 1080-1090.
134. Shi, S., Bianco, P., Robey, P.G., Gronthos, S., 2003. Perivascular niche of postnatal mesenchymal stem cells in human bone marrow and dental pulp. Journal of Bone and Mineral Research. 18, 696-704.

135. Perry, B.C., et al., 2008. Collection, cryopreservation, and characterization of human dental pulp-derived mesenchymal stem cells for banking and clinical use. Tissue Eng Part C Methods. 14, 149-156.

136. Picchi, J., et al., 2013. HOX and TALE signatures specify human stromal stem cell populations from different sources. J Cell Physiol. 228, 879-889.

137. Pierdomenico, L., et al., 2005. Multipotent mesenchymal stem cells with immunosuppressive activity can be easily isolated from dental pulp. Transplantation. 80, 836-842.

138. Ponnaiyan, D., Bhat, K.M., Bhat, G.S., 2012. Comparison of immune-phenotypes of stem cells from human dental pulp and periodontal ligament. Int J Immunopathol Pharmacol. 25, 127-134.

139. Riccio, M., et al., 2013. Human dental pulp stem cells produce mineralized matrix in 2D and 3D cultures. Eur J Histochem. 54, 213-221.

140. Rizk, A., Rabie, A.B., 2013. Human dental pulp stem cells expressing transforming growth factor beta3 transgene for cartilage-like tissue engineering. Cytotherapy. 15, 712-725.

141. Rizk, A., Rabie, B.M., 2013. Electroporation for transfection and differentiation of dental pulp stem cells. Biore. Open Access. 2, 155-162.

142. Rodriguez-Lozano, F.J., et al., 2013. Effects of two low-shrinkage composites on dental stem cells (viability, cell damaged or apoptosis and mesenchymal markers expression). J Mater Sci Mater Med. 24, 979-988.

143. Rodriguez-Lozano, F.J., et al., 2012. Tissue engineering with dental pulp stem cells: isolation, characterization, and osteogenic differentiation. J Craniofac Surg. 23, 571-575.

144. Ryu, J.S., et al., 2009. Gangliosides are involved in neural differentiation of human dental pulp-derived stem cells. Biochem Biophys Res Commun. 387, 266-271.

145. Sakai, K., et al., 2012. Human dental pulp-derived stem cells promote locomotor recovery after complete transaction of the rat spinal cord by multiple neuro-regenerative mechanisms. J Clin Invest. 122, 80-90.

146. Schiraldi, C., et al., 2012. Fighting for territories: time-lapse analysis of dental pulp and dental follicle stem cells in co-culture reveals specific migratory capabilities. Eur Cell Mater. 24, 426-440.

147. Seifritova, M., et al., 2013. Mitoxantrone ability to induce premature senescence in human dental pulp stem cells and human dermal fibroblasts. J Physiol Pharmacol. 64, 255-266.

148. Seifritova, M., et al., 2012. The response of human ectomesenchymal dental pulp stem cells to cisplatin treatment. Int Endod J. 45, 401-412.

149. Seo, M.S., et al., 2013. The effect of mineral trioxide aggregate on odontogenic differentiation in dental pulp stem cells. J Endod. 39, 242-248.

150. Shafiei, F., et al., 2014. Cytotoxic effect of silorane and methacrylated based composites on the human dental pulp stem cells and fibroblasts. Med Oral Patol Oral Cir Bucal. 19, 350-358.

151. Shekar, R., Ranganathan, K., 2012. Phenotypic and growth characterization of human mesenchymal stem cells cultured from permanent and deciduous teeth. Indian J Dent Res. 23, 838-839.

152. Shi, S., Bianco, P., Robey, P.G., Gronthos, S., 2003. Perivascular niche of postnatal mesenchymal stem cells in human bone marrow and dental pulp. Journal of Bone and Mineral Research. 18, 696-704.

153. Sollazzo, V., et al., 2011. Calcium sulfate stimulates pulp stem cells towards osteoblasts differentiation. Int J Immunopathol Pharmacol. 24, 51-57.

154. Son, Y., Lee, E., 2006. Distinct Expression Profiles in Type III Collagen and alpha-Smooth Muscle Actin between Human Dental Pulp Stem Cells and Human Mesenchymal Stem Cells. Molecular Biology of the Cell. 17.

155. Spah, L., et al., 2010. Explant-derived human dental pulp stem cells enhance differentiation and proliferation potentials. J Cell Mol Med. 14, 1635-1644.

156. Stevens, A., et al., 2008. Human dental pulp stem cells differentiate into neural crest-derived melanocytes and have label-retaining and sphere-forming abilities. Stem Cells Dev. 17, 1175-1184.

157. Stokowski, A., et al., 2007. EphB/ephrin-B interaction mediates adult stem cell attachment, spreading, and migration: implications for dental tissue repair. Stem Cells. 25, 156-164.

158. Struys, T., et al., 2013. Magnetic resonance imaging of human dental pulp stem cells in vitro and in vivo. Cell Transplant. 22, 1813-1829.

159. Struys, T., et al., 2011. Ultrastructural and immunocytochemical analysis of multilineage differentiated human dental pulp- and umbilical cord-derived mesenchymal stem cells. Cells, tissues, organs. 193, 366-378.

160. Suchanek, J., et al., 2013. The effect of fetal calf serum on human dental pulp stem cells. Acta Medica (Hradec Kralove). 56, 142-149.

161. Suchanek, J., et al., 2009. Dental pulp stem cells and their characterization. Biomed Pap Med Fac Univ Palacky Olomouc Czech Repub. 153, 31-35.

162. Suchanek, J., et al., 2007. Human dental pulp stem cells--isolation and long-term cultivation. Acta Medica (Hradec Kralove). 50, 195-201.

163. Suh, J-D, et al., 2014. Effects of Co-Culture of Dental Pulp Stem Cells and Periodontal Ligament Stem Cells on Assembled Dual Disc Scaffolds. Tissue Engineering and Regenerative Medicine. 11, 47-58.

164. Suri, L., et al., 2008. Expression of MMP-13 (collagenase-3) in long-term cultures of human dental pulp cells. Archives of Oral Biology. 53, 791-799.

165. Suzuki, T., et al., 2011. Induced migration of dental pulp stem cells for in vivo pulp regeneration. J Dent Res. 90, 1013-1018.

166. Tamaki, Y., et al., 2013. In vitro analysis of mesenchymal stem cells derived from human teeth and bone marrow. Odontology. 101, 121-132.

167. Tammaro, L., et al., 2014. Effect of layered double hydroxide intercalated with fluoride ions on the physical, biological and release properties of a dental composite resin. J Dent. 42, 60-67.

168. Tandon, S., et al., 2010. Dental pulp stem cells from primary and permanent teeth: quality analysis. J Clin Pediatr Dent. 35, 53-58.

169. Tirino, V., et al., 2012. Identification, isolation, characterization, and banking of human dental pulp stem cells. Methods Mol Biol. 879, 443-463.

170. Tom-Kun Yamagishi, V., et al., 2011. Blockade of TLR2 inhibits Porphyromonas gingivalis suppression of mineralized
194. Trubiani, O., et al., 2012. Overexpression of interleukin-6 and -8, cell growth inhibition and morphological changes in 2-hydroxyethyl methacrylate-treated human dental pulp mesenchymal stem cells. Int Endod J. 45, 19-25.

195. Trubiani, O., et al., 2010. The cytotoxic effects of resin-based sealers on dental pulp stem cells. International Endodontic Journal. 43, 646-653.

196. Trubiani, O., et al., 2007. Dental pulp stem cells bioadhesivity: evaluation on mineral-trioxide-aggregate. Int J Immunophathol Pharmacol. 20, 81-86.

197. Uchiyama, M., et al., 2009. Dental Pulp and Periodontal Ligament Cells Support Osteoclastic differentiation. Journal of Dental Research. 88, 609-614.

198. Um, S., et al., 2011. Effect of leptin on differentiation of human dental stem cells. Oral Dis. 17, 662-669.

199. Vandomme, J., et al., 2014. Insulin-Like Growth Factor 1 Receptor and p38 Mitogen-Activated Protein Kinase Signals Inversely Regulate Signal Transducer and Activator of Transcription 3 Activity to Control Human Dental Pulp Stem Cell Quiescence, Propagation, and Differentiation. Stem Cells Dev. 23, 839-851.

200. Varga, I., et al., 2011. Morphological characterization of in vitro expanded human dental pulp-derived stem cells. Biologia. 66, 706-711.

201. Vasandan, A.B., et al., 2014. Functional differences in mesenchymal stromal cells from human dental pulp and periodontal ligament. Journal of Cellular and Molecular Medicine. 18, 344-354.

202. Ventura, C., et al., 2007. Hyaluronan mixed esters of butyric and retinoic Acid drive cardiac and endothelial fate in term placenta human mesenchymal stem cells and enhance cardiac repair in infarcted rat hearts. J Biol Chem. 282, 14243-14252.

203. Vishwanath, V.R., et al., 2013. Differentiation of isolated and characterized human dental pulp stem cells and stem cells from human exfoliated deciduous teeth: An in vitro study. J Conserv Dent. 16, 423-428.

204. Wada, N., et al., 2009. Immunomodulatory properties of human periodontal ligament stem cells. J Cell Physiol. 219, 667-676.

205. Wang, P., et al., 2014. Ginsenoside Rg1 of Panax ginseng stimulates the proliferation, odontogenic/osteogenic differentiation and gene expression profiles of human dental pulp stem cells. Phytomedicine. 21,177-183.

206. Wang, Y., et al., 2013. Osteoblasts can induce dental pulp stem cells to undergo osteogenic differentiation. Cytotechnology. 65, 223-231.

207. Wang, Y., et al., 2013. 10(-7) m 17beta-oestradiol enhances odonto/osteogenic potency of human dental pulp stem cells by activation of the NF-kappaB pathway. Cell Prolif. 46, 677-684.

208. Wang, X., et al., 2012. Comparative characterization of stem cells from human exfoliated deciduous teeth and dental pulp stem cells. Arch Oral Biol. 57, 1231-1240.

209. Wang, J., et al., 2010. Side population increase after simulated transient ischemia in human dental pulp cell. J Endod. 36, 453-458.

210. Weszl, M., et al., 2012. Freeze-dried human serum albumin improves the adhesion and proliferation of mesenchymal stem cells on mineralized human bone allografts. Journal of Orthopaedic Research. 30, 489-496.

211. Woods, E.J., et al., 2009. Optimized cryopreservation method for human dental pulp-derived stem cells and their tissues of origin for banking and clinical use. Cryobiology. 59, 150-157.

212. Yan, X., et al., 2010. iPS cells reprogrammed from human mesenchymal-like stem/progenitor cells of dental tissue origin. Stem Cells Dev. 19, 469-480.

213. Yu, V., et al., 2009. Dynamic hydrostatic pressure promotes differentiation of human dental pulp stem cells. Biochem Biophys Res Commun. 386, 661-665.

214. Zhai, S., et al., 2013. Nematic human dental pulp fibroblasts promote human dental pulp stem cells migration. Exp Cell Res. 319, 1544-1552.

215. Zhang, W., et al., 2011. Human dental pulp progenitor cell behavior on aqueous and hexafluoroisopropanol based silk scaffolds. J Biomed Mater Res A. 97, 414-422.

216. Zhang, W., Ahluwalia, I.P., Yelick, P.C., 2010. Three dimensional dental epithelial-mesenchymal constructs of predetermined size and shape for tooth regeneration. Biomaterials. 31, 7995-8003.

217. Zhang, W., et al., 2008. Hard tissue formation in a porous HA/TCP ceramic scaffold loaded with stromal cells derived from dental pulp and bone marrow. Tissue Eng Part A. 14, 285-294.

218. Zhang, W., et al., 2008. In vivo evaluation of human dental pulp stem cells differentiated towards multiple lineages. J Tissue Eng Regen Med. 2, 117-125.

219. Zhang, W., 2006. Multilineage differentiation potential of stem cells derived from human dental pulp after cryopreservation. Tissue Eng. 12, 2813-2823.

220. Zhao, Z., Liu, H., Wang, D., 2011. ADAM28 manipulates proliferation, differentiation, and apoptosis of human dental pulp stem cells. J Endod. 37, 332-339.

221. Zhao, Z., et al., 2006. ADAM28 participates in the regulation of tooth development. Arch Oral Biol. 51, 996-1005.

222. Zhou, Y., Fan, W., Xiao, Y., 2014. The Effect of Hypoxia on the Stemness and Differentiation Capacity of PDLC and DPC. Biomed Res Int. 2014, 1-7.