Bibliometric Analysis of the 100 Most Cited Articles on Dental Stem Cells

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Aim and objective: A number of research projects are done and papers are published in different disciplines. To evaluate their scholarly effect, a bibliometric study is very useful. The present study is aimed at identifying and characterizing the 100 most cited articles on dental stem cells.

Materials and methods: The Science Citation Index-Expanded tool of Scopus database was used to prepare a list and record the 100 most cited articles on dental stem cell studies on October 15, 2019. Assessments of the articles were done to note down the general details and facts required for bibliometric and citation studies. The software named VOSviewer was used to develop and record a network of collaboration among countries, authors, and keywords.

Results: The articles were published from 2002 to 2017. The most highly cited article received 333 citations, whereas the least was cited 22 times (mean citations 65.76 ± 57.28). A total of 68 journals were involved in publication of the studies on dental stem cells, which were mostly cited. The United States was leading in publication of articles (n = 32) and China was second with 15 publications. The inspection of the document types revealed that there were 59 original research and 39 review papers. A total of 62 out of the 100 most influential articles were funded by 41 organizations. Seoul National University (South Korea) affiliated the most documents (n = 8).

Conclusion: This citation analysis gives an overall general view of the progress and the different kinds of research projects happening in the field of dental stem cell studies.

Clinical significance: The top 100 list selected in this present study will benefit the researchers and scientists in marking the significant areas of research in the field, which will guide them in their upcoming studies and research works.

Keywords: Bibliometric analysis, Citations, Dental stem cell, Most cited articles.

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Introduction
Mesenchymal stem cells are obtained from adult tissues and they possess a major role in regeneration of tissues in various diseases. Mesenchymal stromal cells (MSCs) are multipotent and possess the capacity to differentiate into other types of cells like chondrocytes, cardiomyocytes, osteoblasts, hepatocytes, and adipocytes. Usually, MSCs are isolated from tissues like skin, bone marrow, brain, adipose tissue, myocardium, Wharton’s jelly in the umbilical cord, umbilical cord blood, and granulocyte colony-stimulating factor-mobilized peripheral blood.

Odonotic progenitor cells have been identified as another possible origin of MSCs by Gronthos et al. Tissues of the pulp were used to isolate these cells. This diverse population of dental stem cells (DSCs) located in developing teeth and their surrounding tissues includes stem cells derived from pulpal tissues, stem cells derived from apical papilla, stem cells obtained from the periodontal ligament, and dental follicle precursor cells. Many studies have reported the presence of DSCs in deciduous teeth as well. Dental stem cells mainly arise from neural crest cells but a major proportion is of the glial origin.

Over the past few years, odonotic tissues have turned out to be an appealing source of mesenchymal stem cells. Various studies have been performed, which has led to the publication of many papers on DSCs. Researchers and clinicians might possibly face difficulties to evaluate the quality of these formidable number of publications. Thus, bibliometrics facilitate scientists to figure out the significant research fields and to get an updated version of a
Materials and Methods

Data Source
The Science Citation Index Expanded (SCI-E) section of the Scopus database was used on October 15, 2019, for a thorough literature search by applying the medical term “dental stem cells.” The search provided the 100 most cited articles on DSCs, which were placed in descending order of their citation counts. The citation density was calculated for articles receiving total citations of equal number. Then those papers were arranged in the list with high-citation-density articles being placed higher in the rank list. The articles were evaluated by studying their titles and abstracts in order to obtain the relevant articles on DSC studies. The present study was not subjected to any limitation with respect to time or language in any other.

Data Extraction
The selected articles were evaluated and analyzed by two separate and independent authors who extracted the following information: publication title, number of citations, publication year, citation density, name of the journal, journal category/categories, journal impact factor, quartile, authorship, institution/country of origin of the first author, document type, funding sponsors, affiliations, and evidence levels. A third author was also included to sort out any kind of disagreements.

A software named VOSviewer (version 1.6.13; Leiden University Center for Science and Technology Studies, Leiden, Netherlands) was used for developing the collaboration networks among the authors, countries, and keyword co-occurrence analyzes.

Results
The original search identified a total of 400 articles. The overall h-index and h-index after excluding self-citations are 48 and 46, respectively.

Number of Citations and Citation Density
A total of 6,576 citations were achieved by all the 100 articles selected in this study. The citation numbers had a range of 22 (articles placed in the rank 96–100) to 333 (article with highest citation) with mean citations per article being 65.76. The articles that were ranked in top five in the list received more than 200 citations. The article that received maximum citations (333) was of Young et al. published in the Journal of Dental Research (2002). The articles that followed it were of Ohazama et al. (cited 278 times), Dualib et al. (cited 250 times), Feng et al. (cited 234 times), and Jo et al. (cited 230 times). The present analysis showed that there were five articles that received equal number of citations (22). Thus, their citation densities were calculated in order to place them in the list (Appendix: Table A1).

The highest citation density (29.25) was of an article of Feng et al., titled “Dual origin of mesenchymal stem cells contributing to organ growth and repair.” The article was published in the Proceedings of the National Academy of Science journal (USA) in the year 2011. Chachques et al.'s review article “Cellular cardiomyoplasty for myocardial regeneration” was published in the Asian Cardiovascular and Thoracic Annals journal (2005) and received the lowest citation density (1.85).

Journals Characteristics and Publication Periods
A total of 68 journals were involved in publishing the articles, which received maximum citations (Table 1). Analyzing the journals thoroughly, it was revealed that maximum contribution (n = 7) was from the journal named the Journal of Dental Research and then there were Biomaterials journal, International Endodontic Journal, Regenerative Medicine, and Tissue Engineering Part A, contributing four papers each. A total of 52 out of 68 journals had a contribution of one paper each in the top 100 list.

Biochemistry, genetics, and molecular biology were the major subject areas for 47 papers. This was followed by dentistry (n = 35), medicine (n = 28), engineering (n = 19), material science (n = 14), and chemical engineering (n = 11) categories. Among the 68 journals, 37 (54.41%) were positioned in the first quartile, 23 (33.82%) in the second, 3 (4.41%) in the third category, and 2 (2.94%) in the fourth quartile. The quartiles of two journals were not available (Iranian Journal of Reproductive Medicine and Schweizer Monatsschrift für Zahnmedizin = Revue mensuelle suisse d’odontolo-stomatologie = Rivista mensile svizzera di odontologia e stomatologia/SSO), and one journal (Tissue Engineering) had no quartile assigned to it yet.

All the contributing journals’ impact factors (IFs) were recorded. They had a range of 1.154–17.161 (with the mean being 2.93 ± 3.24). A total of 43 out of the 100 articles appeared in journals that had IF less than 5. It was noted that the journal Science Translational Medicine had an IF (17.161) that was the highest among all, whereas the Gene Expression Patterns journal had the lowest IF (1.154). Both the journals contributed one article each. Two journals had IFs of more than 15 (Trends in Cell Biology and Science Translational Medicine), while five were more than 5 (Journal of Dental Research, Biomaterials, Analytical Chemistry, Proceedings of the National Academy of Sciences of the United States of America, and Stem Cells).

Each and every article selected in the study was published in English. The years 2002–2017 (a period of 15 years) were active in publishing these papers. The decade 2010s published the maximum number of articles (n = 75), whereas the decade 2000s contributed only 25 papers (Table 2). The year 2011 had the maximum publications (n = 16) and the year 2014 was next in the rank list (n = 14). Most of the papers (n = 75) appeared in 2010 and after.

Authors and Countries of Origin
A total of 160 researchers authored the 100 articles, which received maximum citations. The analysis also showed that the selected articles had a minimum of 1 author (n = 6) and a maximum of 21 authors (n = 1). Total 6 papers had single author, 14 had two authors.
And 8 and 14 papers involved the contribution of three and four authors, respectively; the rest of the 58 papers were contributed by five authors or more. Of the 100 most cited articles, a single author had five papers to his credit, whereas 19 researchers authored three or more papers. Schmalz was the only author with five distinguished papers. Choung, Moraleda, Nakahara, Park, and Rodrago-z Lozano contributed 4 articles each in the most cited list.

A network of collaboration was developed among the coauthors who had a contribution of two articles or more (Fig. 1). The network was led by Zhang W and Wang involving 17 and 15 authors each, while Zhang H, Huang, Haydon, Yan, Zhang Z, Deng, Lou, He, and Deng had collaborations with 12 authors each. The nodal size is a representation of the article numbers published by each author and the joining lines are representations of the number of publications that have been coauthored by two researchers.

Each article’s first author was taken note of and the author’s country of origin was searched using internet tools. The search showed that researchers from 28 nations had a contribution toward the 100 top cited articles (Table 2). The United States published 32 papers, which was the highest. China (n = 15), South Korea (n = 14), Germany, and Japan (n = 9), and United Kingdom (n = 7) followed United States. Figure 2 represents a network of collaborations among countries formed by application of a threshold of three or more collaborations. The United Kingdom and the United States had most of the international collaborations.

### Type of Document
The top 100 list consisted of 59 articles, 39 review papers, 1 book chapter, and 1 short survey (Table 2).

### Funding Sponsors and Affiliations
Out of the 100 articles, 62 were sponsored by 41 organizations. The National Institutes of Health and the National Natural Science Foundation of China funded 8 and 7 papers, respectively. 8 organizations sponsored 2 papers each while 31 organizations funded 1 paper each.

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**Table 1:** Top journals with their individual contribution to the 100 most cited articles on DSCs

| S. no | Journal name                  | IF (2017/2018) | Quartile | Category/ies                                      | No of articles |
|-------|--------------------------------|---------------|----------|--------------------------------------------------|---------------|
| 1     | Journal of Dental Research     | 5.125         | 1        | Dentistry                                        | 07            |
| 2     | Biomaterials                   | 10.273        | 1        | Biochemistry, Genetics, and Molecular biology    | 04            |
|       |                                |               |          | Chemical engineering                             |               |
|       |                                |               |          | Engineering                                       |               |
|       |                                |               |          | Materials science                                |               |
| 3     | International Endodontic Journal | 3.331         | 1        | Dentistry                                        | 04            |
| 4     | Regenerative Medicine          | 2.383         | 2        | Engineering                                       | 04            |
| 5     | Tissue Engineering Part A      | 3.616         | 1        | Biochemistry, Genetics, and Molecular biology    | 04            |
|       |                                |               |          | Chemical engineering                             |               |
|       |                                |               |          | Engineering                                       |               |
|       |                                |               |          | Materials science                                |               |
| 6     | Clinical Oral Investigations   | 2.453         | 1        | Dentistry                                        | 03            |
| 7     | Journal of Dentistry           | 3.280         | 1        | Dentistry                                        | 03            |
| 8     | Stem Cells and Development     | 3.147         | 1        | Biochemistry, Genetics, and Molecular biology    | 03            |
|       |                                |               |          | Chemical engineering                             |               |
|       |                                |               |          | Engineering                                       |               |
|       |                                |               |          | Materials science                                |               |
| 9     | Current Topics in Developmental Biology | NA | 4        | Biochemistry, Genetics, and Molecular Biology | 02            |
| 10    | Dental Clinics of North America | NA           | 2        | Dentistry                                        | 02            |

**Table 2:** Journal characteristics of the 100 most cited articles on DSCs

| Item                              | Description               | No. of articles |
|-----------------------------------|---------------------------|-----------------|
| Year-wise distribution of papers  |                           | 25              |
| 2000s                             |                           |                 |
| 2010s                             |                           | 75              |
| Country of origin with five or more papers | United States | 32              |
|                                   |                           |                 |
|                                   |                           |                 |
|                                   |                           |                 |
|                                   | China                     | 15              |
|                                   | South Korea               | 14              |
|                                   | Germany                   | 09              |
|                                   | Japan                     | 09              |
|                                   | United Kingdom            | 07              |
|                                   | Spain                     | 06              |
|                                   | Brazil                    | 05              |
| Type of document                  | Original research         | 59              |
|                                   | Review papers             | 39              |
|                                   | Book chapter              | 01              |
|                                   | Short survey              | 01              |
| Institutions which affiliated four or more articles | Seoul National University | 8               |
|                                   | King’s College London     | 06              |
|                                   | Universitat Regensburg    | 05              |
|                                   | Universidad de Murcia     | 04              |
|                                   | Forsyth Institute         | 04              |
|                                   | Harvard Medical School    | 04              |
|                                   | Nippon Dental University  | 04              |
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Seoul National University affiliated eight documents (Table 2) followed by King’s College London (n = 6) and University of Regensburg (n = 5).

Keywords
The total number of keywords identified were 1,449. Figure 3 displays the network of co-occurrence of keywords. The node “human” was the biggest and had an appearance of 81 times. The next node was “humans” appearing 70 times and then “stem cells,” which appeared 61 times. A node size is a representation of the keyword appearances. The joining lines are representations of the strength of co-occurrence with other keywords. Two words are closer to each other if they have co-occurred recurrently in the articles evaluated.

Discussion
The citation analysis is a good means to spot the prominent articles in different fields of research. The number of times an article has been listed in the reference column of other articles is generally accepted as a mark of distinction. Such bibliometric study approaches help readers without any prior deep knowledge of a specific field to get an overview of the topics, the set of promising researchers, or the most significant papers in that particular field. Garfield has stated that papers receiving citations of 100 and above are marked as classic papers. A comprehensive study of the classic papers will help the new researchers to be updated and aware of such kind of classic knowledge. A total of 15 classic papers were a part of this study.

Odontogenic tissues, in the past few years, have been a favorable mesenchymal stem cell source and are usually preferred over conventional mesenchymal stem cells derived from the bone marrow because of easy availability by a noninvasive method, high proliferative capacity, and capability of multilineage differentiation. Tissues of pulp polyp have also been reported to comprise of cells with stem cell properties. Studies have been done on DSCs with respect to their isolation methods, cryopreservation, and role in regenerative medicine. Some researchers have indicated the potential application of DSCs in various clinical conditions like neurodegenerative diseases, myocardial infarction, and diabetes.

For the very first time, a bibliometric analysis has been done on DSC articles briefing the features of the articles that have received the maximum citations.

For publication of high-quality papers, authors usually prefer journals having high IFs. Previous bibliometric studies have shown positive correlation between journal’s IF and citation frequency. However, the results of this study contradict the previous study reports. In recent times, researchers tend to choose specialty journals over the high IF journals for publishing their high-quality papers. Most of the top articles have appeared in the Journal of Dental Research (IF = 5.38), one of the illustrious journals related to various aspects of research in dentistry. It is quite evident that the maximum number of papers (n = 7) on DSC has been published in this journal.

Fig. 1: Collaboration among countries

![Collaboration among countries](image-url)
The greatest output was from the decade 2010s with 75 articles. Time has a significant impact on citation analysis. Ample time is available for older articles to gather enough citations compared to the articles published in recent times regardless of their scientific impact. However, in this study, three papers from recent 2017 acquired positions in the top 100 list. The papers of 2017, “Therapeutic potential of dental stem cells,” “Evaluation of cytocompatibility of calcium silicate-based endodontic sealers and their effects on the biological responses of mesenchymal dental stem cells,” and “Cryopreservation of human dental follicle tissue for use as a resource of autologous mesenchymal stem cells” were cited 37, 26, and 22 times, respectively. The citation density of each and every article was calculated to rule out the time bias. It brought forward each article’s scientific impact, annually. The value of $R = 0.4928$, $p$ value $< 0.00001$ (the result is significant at $p < 0.05$). Technically, a positive correlation was observed between two factors, i.e., duration of publication and number of citations achieved. Yet their relationship was found to be weak.

The United States was the productive country of all as it had a contribution of 32 publications. It is noted that the United States is always ahead in terms of research works in the field of health sciences, which might be due to the huge support it gets financially for conducting the research projects. Another advantage of Scopus over Web of Science is that Scopus provides a 20% more coverage, whereas results of inconsistent accuracy are provided by Google Scholar. A bibliometric analysis generally gives a quantitative measure of an article rather than reflecting its quality. Authors usually incline to refer previous highly cited research works regardless of their content. This is referred to as the snowball effect. Moreover, bibliometric studies also face “obliteration by incorporation” effect, wherein the sources of the widely accepted bibliometric studies. The Scopus Database provided the citation data. There are possibilities that the good impactful papers included in databases such as Google Scholar and Web of Science might got omitted in this citation analysis study. The advantage of the Scopus database of automatically excluding self-citations was the reason for preferring and using this database for the current study. In a bibliometric analysis in the field of health science, the study of the level of evidence of papers is quite common. A careful analysis of its classification system reveals that the classifications are related to clinical studies that have a clinical outcome.

Majority of the papers were original research projects ($n = 59$). There were no papers in the category of case reports and editorials. Analysis of levels of evidence (also known as hierarchy of evidence) of research articles helps in making clinical decisions. In a bibliometric analysis in the field of health science, the study of the level of evidence of papers is quite common. A careful analysis of its classification system reveals that the classifications are related to clinical studies that have a clinical outcome. Hence, levels of evidence analysis could not be carried out.

There are certain limitations in this kind of bibliometric studies. The Scopus Database provided the citation data. There are possibilities that the good impactful papers included in databases such as Google Scholar and Web of Science might got omitted in this citation analysis study. The advantage of the Scopus database of automatically excluding self-citations was the reason for preferring and using this database for the current study. Another advantage of Scopus over Web of Science is that Scopus provides a 20% more coverage, whereas results of inconsistent accuracy are provided by Google Scholar. A bibliometric analysis generally gives a quantitative measure of an article rather than reflecting its quality. Authors usually incline to refer previous highly cited research works regardless of their content. This is referred to as the snowball effect. Moreover, bibliometric studies also face “obliteration by incorporation” effect, wherein the sources of the widely accepted....

**Fig. 2:** Coauthor contribution with two or more articles with their network in the top-cited papers
results are usually forgotten. Thus, those landmark studies struggle to achieve few numbers of citation over the years. There is also a major effect of time on the citation analysis. Previously published articles have a privilege of receiving more citations than the recent ones. Despite the limitations, the study provides a brief summary of the characteristics of the DSC literature.

**Conclusion**

As far as we are aware, a study on the citation and bibliometric analysis of the 100 most cited articles on DSCs has been done for the very first time. The 100 selected papers in this study were all published in English language. Most of the publications were in the 2010s decade. Authors from the United States and Asian countries like China, South Korea, and Japan had major shares in publications. The top 100 list selected in this present study will certainly be an essential source of information for scientists and researchers. Scientists and researchers will benefit from such a study to figure out the focus of research in the field and it will also guide them to plan out the subsequent works and advances to be done in the particular field.

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| Rank | Article                                                                                                                                   | Scopus citations | Scopus citation density |
|------|-------------------------------------------------------------------------------------------------------------------------------------------|------------------|------------------------|
| 1    | Tissue engineering of complex tooth structures on biodegradable polymer scaffolds                                                        | 333              | 19.58                  |
| 2    | Stem-cell-based tissue engineering of murine teeth                                                                                         | 278              | 18.53                  |
| 3    | Bioengineered teeth from cultured rat tooth bud cells                                                                                       | 250              | 16.66                  |
| 4    | Dual origin of mesenchymal stem cells contributing to organ growth and repair                                                             | 234              | 29.25                  |
| 5    | Isolation and characterization of postnatal stem cells from human dental tissues                                                          | 230              | 19.16                  |
| 6    | Direct effect of intracanal medicaments on survival of stem cells of the apical papilla                                                   | 180              | 25.71                  |
| 7    | Stem cell-delivery therapeutics for periodontal tissue regeneration                                                                       | 150              | 21.42                  |
| 8    | Stem cells in dentistry—Part I: Stem cell sources                                                                                          | 142              | 20.28                  |
| 9    | Stem cell-based biological tooth repair and regeneration                                                                                   | 139              | 15.44                  |
| 10   | Characterization of human DSCs and buccal mucosa fibroblasts                                                                               | 133              | 12.09                  |
| 11   | Odontogenic capability: Bone marrow stromal stem cells vs dental pulp stem cells                                                          | 132              | 11                     |
| 12   | Self-assembling peptide amphiphile nanofibers as a scaffold for DSCs                                                                      | 121              | 11                     |
| 13   | Concise reviews: Characteristics and potential applications of human dental tissue-derived mesenchymal stem cells                           | 114              | 28.5                   |
| 14   | Efficacy of periodontal stem cell transplantation in the treatment of advanced periodontitis                                               | 114              | 14.25                  |
| 15   | A paradigm shift in endodontic management of immature teeth: Conservation of stem cells for regeneration                                   | 101              | 9.18                   |
| 16   | Recommendations for using regenerative endodontic procedures in permanent immature traumatized teeth                                        | 94               | 13.42                  |
| 17   | Pulp and dentin tissue engineering and regeneration: Current progress                                                                        | 94               | 9.4                    |
| 18   | Stem cells and tooth tissue engineering                                                                                                    | 91               | 8.27                   |
| 19   | Mesenchymal stem cells in the dental tissues: Perspectives for tissue regeneration                                                          | 90               | 11.25                  |
| 20   | Induced migration of dental pulp stem cells for in vivo pulp regeneration                                                                   | 88               | 11                     |
| 21   | Somatic stem cells for regenerative dentistry                                                                                            | 88               | 8                      |
| 22   | Photoactivation of endogenous latent transforming growth factor-β1 directs DSC differentiation for regeneration                               | 86               | 17.2                   |
| 23   | Stem cells in dentistry—Part II: clinical applications                                                                                      | 84               | 12                     |
| 24   | Advances in defining regulators of cementum development and periodontal regeneration                                                        | 80               | 6.66                   |
| 25   | Bioengineered dental tissues grown in the rat jaw                                                                                           | 76               | 6.90                   |
| 26   | Bioengineering of DSCs in a PEGylated fibrin gel                                                                                           | 75               | 9.37                   |
| 27   | Cell fate determination during tooth development and regeneration                                                                         | 73               | 7.3                    |
| 28   | Canonical Wnt signaling acts synergistically on BMP9-induced osteo/odontoblastic differentiation of stem cells of dental apical papilla (SCAPs) | 72               | 18                     |
| 29   | Mesenchymal stem cells derived from dental tissues                                                                                          | 72               | 9                      |
| 30   | Dental pulp and dentin tissue engineering and regeneration: Advancement and challenge                                                       | 71               | 8.87                   |
| 31   | MicroRNAs play a critical role in tooth development                                                                                         | 71               | 7.88                   |
| 32   | Identification of putative dental epithelial stem cells in a lizard with lifelong tooth replacement                                             | 69               | 7.66                   |
| 33   | Comparison of human dental follicle cells (DFCs) and stem cells from human exfoliated deciduous teeth (SHED) after neural differentiation in vitro | 68               | 7.55                   |
| 34   | Effect of cryopreservation on biological and immunological properties of stem cells from apical papilla                                           | 67               | 7.44                   |
| 35   | Tissue interactions regulating tooth development and renewal                                                                               | 65               | 16.25                  |
| 36   | New perspectives on tooth development and the DSC niche                                                                                     | 65               | 4.33                   |
| 37   | Functional tooth restoration by allogeneic mesenchymal stem cell-based bioroot regeneration in swine                                         | 62               | 10.33                  |
| 38   | Tissue engineering in dentistry                                                                                                            | 58               | 11.6                   |
| 39   | Photonic crystal-enhanced microscopy for imaging of live cell adhesion                                                                     | 53               | 8.83                   |
| 40   | Osteoblastic/cementoblastic and neural differentiation of DSCs and their applications to tissue engineering and regenerative medicine        | 53               | 7.57                   |

Contd…
| Rank | Article                                                                 | Scopus citations | Scopus citation density |
|------|-------------------------------------------------------------------------|------------------|-------------------------|
| 41   | DSCs and their promising role in neural regeneration: An update        | 52               | 8.66                    |
| 42   | Assessment of the impact of two different isolation methods on the osteo/odontogenic differentiation potential of human DSCs derived from deciduous teeth | 52               | 6.5                     |
| 43   | DSC therapy with calcium hydroxide in dental pulp capping             | 52               | 5.77                    |
| 44   | In vitro analysis of mesenchymal stem cells derived from human teeth and bone marrow | 51               | 8.5                     |
| 45   | Differentiation of human DSCs reveals a role for microRNA-218         | 50               | 10                      |
| 46   | Mesenchymal DSCs in regenerative dentistry                             | 50               | 7.14                    |
| 47   | DSCs and their potential role in apexogenesis and apexification      | 49               | 4.9                     |
| 48   | Neural crest stem cells from dental tissues: A new hope for dental and neural regeneration | 48               | 6.85                    |
| 49   | Effects of composite films of silk fibroin and graphene oxide on the proliferation, cell viability, and mesenchymal phenotype of periodontal ligament stem cells | 47               | 9.4                     |
| 50   | Future dentistry: Cell therapy meets tooth and periodontal repair and regeneration | 47               | 5.87                    |
| 51   | Bone morphogenetic protein-9 effectively induces osteo/odontoblastic differentiation of the reversibly immortalized stem cells of dental apical papilla | 46               | 9.2                     |
| 52   | Pro-angiogenic impact of DSCs in vitro and in vivo                   | 41               | 8.2                     |
| 53   | Age-dependent impaired neurogenic differentiation capacity of DSC is associated with wnt/β-catenin signaling | 41               | 6.83                    |
| 54   | Regulation of epithelial stem cells in tooth regeneration             | 41               | 3.41                    |
| 55   | Immunomodulatory properties of dental tissue-derived mesenchymal stem cells | 40               | 8                       |
| 56   | Biological approaches toward dental pulp regeneration by tissue engineering | 40               | 5                       |
| 57   | Expression patterns of ABCG2, Bmi-1, Oct-3/4, and Yap in the developing mouse incisor | 40               | 5                       |
| 58   | Potential role of DSCs in the cellular therapy of cerebral ischemia   | 40               | 4                       |
| 59   | Multilineage potential and proteomic profiling of human DSCs derived from a single donor | 39               | 7.8                     |
| 60   | From molecules to mastication: The development and evolution of teeth | 38               | 6.33                    |
| 61   | Dental tissue regeneration—a mini-review                             | 38               | 4.22                    |
| 62   | Therapeutic potential of DSCs                                        | 37               | 18.5                    |
| 63   | Simple and integrated Spintip-based technology applied for deep proteome profiling | 37               | 12.33                   |
| 64   | Effect of platelet-rich plasma on DSCs derived from human impacted third molars | 37               | 4.62                    |
| 65   | Side population cells expressing ABCG2 in human adult dental pulp tissue | 37               | 3.08                    |
| 66   | Combination of aligned PLGA/Gelatin electrospun sheets, native dental pulp extracellular matrix, and treated dentin matrix as substrates for tooth root regeneration | 35               | 8.75                    |
| 67   | DSCs for tooth regeneration and repair                               | 35               | 3.5                     |
| 68   | A review of new developments in tissue engineering therapy for periodontitis | 35               | 2.69                    |
| 69   | Osteogenic differentiation of mesenchymal stem cells from dental bud: Role of integrins and cadherins | 34               | 8.5                     |
| 70   | DSCs and their sources                                               | 34               | 4.85                    |
| 71   | CD146 expression influences periapical cyst mesenchymal stem cell properties | 33               | 11                      |
| 72   | Coculture of stem cells from apical papilla and human umbilical vein endothelial cell under hypoxia increases the formation of three-dimensional vessel-like structures in vitro | 32               | 8                       |
| 73   | Hypoxia modulates the differentiation potential of stem cells of the apical papilla | 32               | 6.4                     |
| 74   | Odontogenic induction of DSCs by extracellular matrix-inspired three-dimensional scaffold | 32               | 6.4                     |
| 75   | The effects of platelet-rich plasma derived from human umbilical cord blood on the osteogenic differentiation of human DSCs | 32               | 4                       |
| 76   | Tooth regeneration: Implications for the use of bioengineered organs in first-wave organ replacement | 32               | 2.66                    |
| 77   | Current understanding of the process of tooth formation: Transfer from the laboratory to the clinic | 30               | 6                       |
| 78   | Tissue engineering approaches for regenerative dentistry             | 30               | 3.75                    |

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| Rank | Article                                                                 | Scopus citations | Scopus citation density |
|------|-------------------------------------------------------------------------|------------------|------------------------|
| 79   | Neural crest-derived DSCs—where we are and where we are going          | 29               | 5.8                    |
| 80   | Phenotypic characterizations and comparison of adult DSCs with adipose-derived stem cells | 28               | 3.11                   |
| 81   | Efficient functionalization of alginate biomaterials                   | 27               | 9                      |
| 82   | Dental stem cells—characteristics and potential                         | 27               | 5.4                    |
| 83   | Chondrogenesis of periodontal ligament stem cells by transforming growth factor-β3 and bone morphogenetic protein-6 in a normal healthy impacted third molar | 27               | 4.5                    |
| 84   | Evaluation of cytocompatibility of calcium silicate-based endodontic sealers and their effects on the biological responses of mesenchymal DSCs | 26               | 13                     |
| 85   | Regenerative applications using tooth-derived stem cells in other than tooth regeneration: A literature review | 26               | 8.66                   |
| 86   | Review scaffold design and stem cells for tooth regeneration            | 26               | 4.33                   |
| 87   | Cellular cardiomyoplasty for myocardial regeneration                   | 26               | 1.85                   |
| 88   | Stem cell-based approaches in dentistry                                 | 25               | 6.25                   |
| 89   | Status and potential commercial impact of stem cell-based treatments on dental and craniofacial regeneration | 25               | 1.92                   |
| 90   | Bioactivity of periodontal ligament stem cells on sodium titanate coated with graphene oxide | 24               | 8                      |
| 91   | A pituitary homeobox 2 (Pitx2): microRNA-200a-3p:β-catenin pathway converts mesenchymal cells to amelogenin-expressing dental epithelial cells | 24               | 4.8                    |
| 92   | Potential feasibility of DSCs for regenerative therapies: stem cell transplantation and whole-tooth engineering | 24               | 3                      |
| 93   | Critical review in oral biology & medicine: Transcriptomes and proteomes of dental follicle cells | 24               | 2.66                   |
| 94   | Gene expression profile in mesenchymal stem cells derived from dental tissues and bone marrow | 23               | 2.87                   |
| 95   | Dental tissue—new source for stem cells                                | 23               | 2.3                    |
| 96   | Cryopreservation of human dental follicle tissue for use as a resource of autologous mesenchymal stem cells | 22               | 11                     |
| 97   | Current overview on DSCs applications in regenerative dentistry         | 22               | 5.5                    |
| 98   | Characterization of mesenchymal stem cells from human dental pulp, preapical follicle, and Periodontal ligament | 22               | 3.66                   |
| 99   | Lipopolysaccharide from *Escherichia coli* but not from *Porphyromonas gingivalis* induce pro-inflammatory cytokines and alkaline phosphatase in dental follicle cells | 22               | 3.14                   |
| 100  | Stem cells—prospects in dentistry.                                     | 22               | 2.44                   |