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Dental pluripotent cells - a promise for tissue regeneration

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ABSTRACT

Pluripotent cell biology has become an important field for the understanding of tissue regeneration and implementation of regenerative medicine. The objective of this review is to highlight the biology, sources and potential applications of pluripotent cells with emphasis on a dentist's role in using pluripotent cells from teeth. A literature review was performed in PubMed Central,Google scholar and Cochrane library using Mesh Terms– 'Dental stem cells', 'Periodontal' and 'Pulpal'. With this combination total of 101 abstracts appeared. Out of these 39 titles/abstracts were related to the research question. Further search criteria's were applied to the articles out of which 11 articles which fulfilled the criteria's were selected for the review. 04 articles which was hand searched were also included. It was found that human pluripotent cells have been isolated from the dental pulp, exfoliated deciduous teeth, the periodontal ligament, the dental follicle, differentiate into many dental components and may provide therapeutic benefits. They are capable of replicating themselves and can be readily recovered at the time of a planned dental procedure. Furthermore, our data clearly show that these cells have high potential to serve as resources not for medical therapies and tissue engineering, but also for dental or bone reconstruction.

Keywords: dental stem cells, dental pulp, periodontal, tissue regeneration, Pluripotent cells.

Introduction

Human body is intricate system consisting of numerous cells and tissues working in an organized fashion for the sustenance of life. The smallest living unit of a human body is a cell and is made up of trillions of them. Cells are important for many reasons. They produce the energy to do daily activities, hold the coded instructions for everything from the color of our hair to whether we have freckles or not.

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Cells differentiate from each other to perform different, important tasks within the body. [1]Ultimately, every cell in the human body can be traced back to a fertilized egg that came into existence from the union of egg and sperm. But the body is made up of over 200 different types of cells, not just one. All of these cell types come from a pool of stem cells in the early embryo. During early development, as well as later in life, various types of Pluripotent cells give rise to the specialized or differentiated cells that carry out the specific functions of the body, such as skin, blood, muscle, and nerve cells. [2]Pluripotent cells are special category of human cells which have important role in diseasepreventionandtreatment.These are undifferentiat ed biologicalcells thatcan differentiate intospecializedc ellsandcan divide (through mitosis) to produce more

stem cells. They are found in multicellular organisms. [3] The words pluripotent cells, also known as 'stem cells' were first used by Haeckel in 1868 to describe the origin of multicellular organisms from unicellular organisms. Regaud in 1901 used the term first for self renewal for spermatogonial stem cells in testis. He recognized that for spermatogenesis to occur there must be a self renewing ancestral cell. [4]Early studies of human development had demonstrated that the cells of the embryo were capable of producing every cell type in the human body. Scientists were able to extract embryonic Pluripotent cells from mice in the 1980s, but it wasn't until 1998 that a team of scientists from the University of Wisconsin–Madison became the first group to isolate human embryonic stem cells and keep them alive in the laboratory. Stem cells are defined as 'clonogenic cells capable of both self-renewal & multi-lineage'. In culture, they have a remarkable viability and proliferative capacity. All these characteristics make them a favorite cell source for tissue engineering. In mammals there are two broad types of Pluripotent cells: embryonic, which are isolated from the inner cell mass of blastocysts, and adult Pluripotent cells, which are found in various tissues. In adult organisms, Pluripotent cells and progenitor cells act as a repair system for the body, replenishing adult tissues. [2]These progenitor cells vary in their degree of plasticity (developmental versatility) according to their potency as Totipotent, Pluripotent, Multipotent or Tissue-resident Stem Cells,Oligopotent ,Unipotent cells.[3]Dental exfoliation in humans is a genetically regulated event during childhood. If the permanent teeth are damaged or lost, they do not regenerate. At present, teeth can only be replaced with conventional prostheses; however, progress in pluripotent cell biology and tissue engineering may present new options for replacing heavily damaged or lost teeth, or even individual tooth structures. The promise of such treatment possibilities puts pluripotent cells in the focus of dental research. [5] Dental stem cells can be obtained from the pulp of the primary and permanent teeth, from the periodontal ligament, and from associated healthy tissues. Exfoliating/extracted deciduous teeth and permanent teeth extracted for orthodontic treatment, trauma or dental implant indications are all readily available sources of dental stem cells. The harvest of these dental stem cells results in minimal trauma. Dental professionals have the opportunity to make their patients aware of these new sources of stem cells that can be stored for future use as new therapies are developed for a range of diseases and injuries.[6]The discovery of pluripotent cells in teeth helped us to have an accessible and available source of stem cells. Using one's own stem cells for medical treatment means a much lower risk of rejection by the body and decreases the need for powerful drugs that weaken the immune system, both of which are negative but typical realities that come into play when tissues or cells from a donor are used to treat patients. Further, the pluripotent cells from teeth have been observed in research studies to be among the most powerful stem cells in the human body. Stem cells from teeth replicate at a faster rate and for a longer period of time than do stem cells harvested from other tissues of the body. Pluripotent cells in the human body age over time and their regenerative abilities slow down later in life. [7]Adult stem cells which are derived from tooth structures have been receiving the attention of researchers over the past decade and inspiring hope for practical applications in the future. Dental stem cells are a valuable source of stem cells and are found in teeth with healthy pulp Till date five different human dental stem cells have been isolated and characterized: Dental Pulp Stem Cells (DPSCs), Stem Cells From Exfoliated Deciduous Teeth (SHED), Periodontal Ligament Stem Cells (PDLSCs), Stem Cells From Apical Papilla (SCAP) and Dental Follicle Progenitor Cells (DFPCs). The discovery of dental stem cells and recent advances in cellular and molecular biology have led to the development of novel therapeutic strategies that aim at the regeneration of oral tissues that were injured by disease or trauma. [8]Now, dental professionals have the opportunity to make their patients aware of these new sources of stem cells that can be conveniently recovered and remotely stored for future use as new therapies are developed for a range of diseases and injuries.Dental applications under investigation are: a) Craniofacial regeneration, b) Cleft lip and palate, c) Tooth regeneration, d) Pulp regeneration, e) Periodontal ligament regeneration f) Enamel and dentin production [9].Though there is literature available on stem cells, very limited is said on dental stem cells and hence an attempt is made in this review to give the dental surgeon a prior insight of the unprecedented opportunities of oral and tooth tissue regeneration.

Materials and method

Search criteria

Inclusion criteria

- All the experimental and non experimental studies done on humans are included in the study.
- Both the *in vivo* and *in vitro* studies done on humans are included
- All the original research articles are included.

Exclusion criteria

- Studies done on animal models are not included
- Studies done on dental stem cells with other stem cells are not included
- Review articles are not included

Search Strategy

A literature review was performed using pubmed central, google scholar and Cochrane library. MESH Terms – pluripotent cells, dental stem cells, periodontal and pulpal were combined for the search. A total of 105 abstracts appeared with the above mentioned MESH Terms. Out of these 39 titles/abstracts were related to the research question. When articles were scrutinized according to the inclusion and exclusion criteria, a total of 15 articles fulfilled the criteria and were selected for the review. Four articles which were hand searched were also included in the review. (Figure 1)

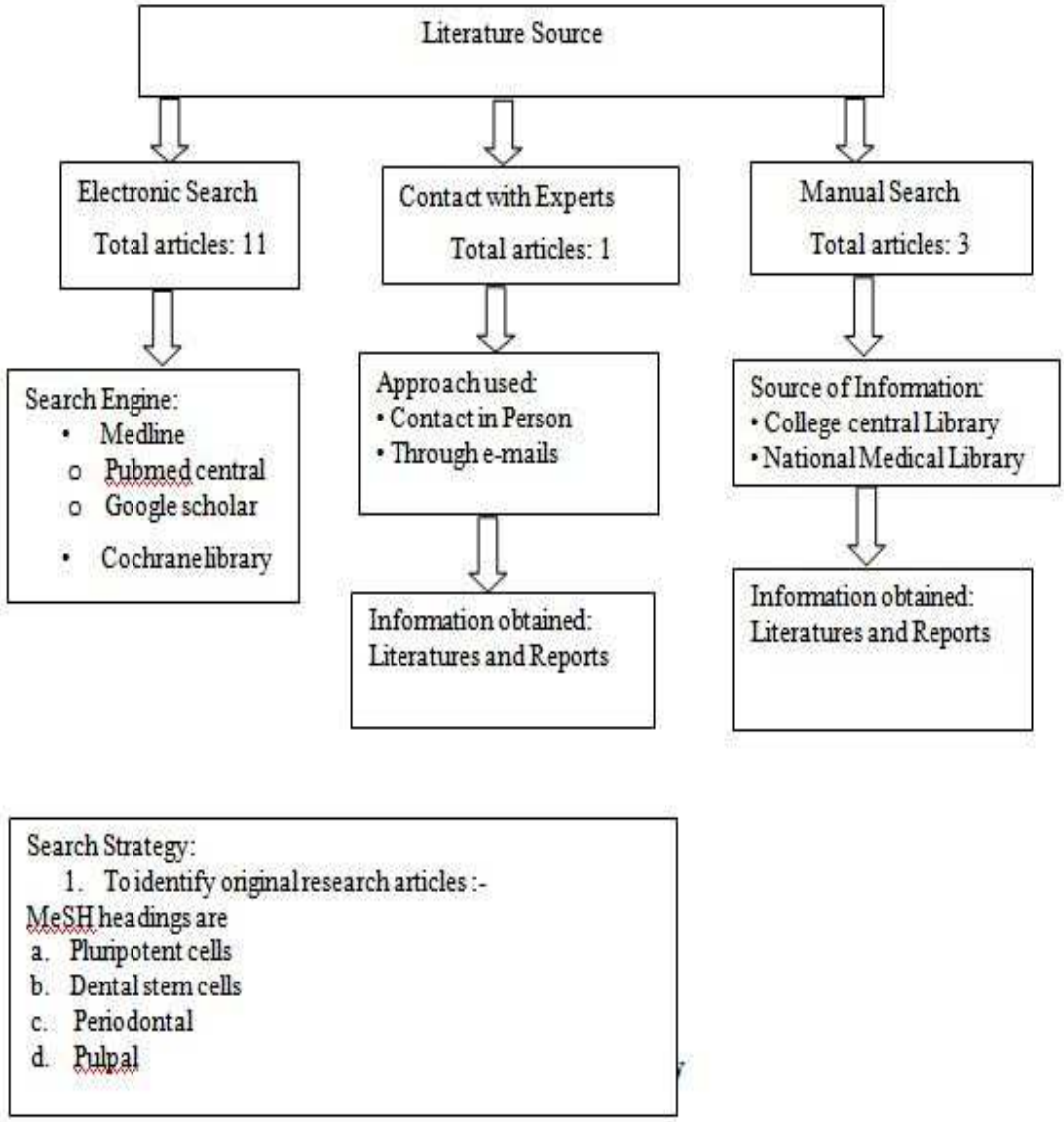

Figure 1: Search Strategy

* Search strategy for the available literature through electronic database, manual records and personal contact.

Table No.1: summarizes the review of the available literature in terms of sample size, study design, outcome variables and results

Study	Title	Sample size	Patient characteristic	Cell type(s)	Study design	Factor(s) influence	Target cells	Results/ summary
F Feng, K *et al* in 2010[10]	Utility of PDL progenitors for in vivo tissue regeneration: a report of 3 cases	16 teeth	Three male patients, 25 (patient nos. 1 and 2) and 42 (patient no. 3) years of age, with periodontitis and pocket depth of 4.8 to 10 mm . 12 teeth involved in patient no. 1, 3 teeth in patient no. 2 and 1 tooth in patient no. 3	PDLSCs	Both In vivo study and *in vitro* study	chronic generalized periodontitis, , presence of at least one deep intrabony defect with probing depth of ≥6 mm.	PDL tissues	**1. Transplantation of PDLPs may provide therapeutic benefit for the periodontal defects. 2. PDLPs were analogous to PDLSCs in terms of high proliferation, expression of mesenchymal surface molecules, multipotent differentiation, and *in vivo* tissue regain.**
Su Kim - Hwan *et al* in 2011[11]	Gene expression profile in mesenchymal stem cells derived from dental tissues and bone marrow	5 samples	5 samples of bone-marrow-derived mesenchymal stem cells (BMSCs) (n=1), periodontal ligament stem cells (PDLSCs) (n=2), and dental pulp stem cells (DPSCs) (n=2). and selected samples are tooth extraction for orthodontic reasons, general good health, absence of peri-odontal disease, and being a non smoker	PDLSCs	Experimental study	good health, absence of peri-odontal disease, and non smoking condition .	Mesenchymal stem cells	**1. Anatomical structure development and anatomical structure morphogenesis gene ontology (GO) terms were over-represented in all three dif-ferent mesenchymal stem cells.**
Jain Rashi Khanna *et al*	Growth and Differentiation of Human Dental Pulp Stem Cells Maintained	4 patients	Human dental pulp explants were obtained from partially or	DPSCs	Both *In vivo* study and *in vitro*	partially or completely impacted	DPSCs	**1.HS is a suitable alternative to FBS for the expansion of**

in 2012[12]	in Fetal Bovine Serum, Human Serum and Serum-free/Xeno-free Culture Media		completely impacted third molar teeth of 4 patients, aged 21-26 years (23 ± 2.5 years).		study	third molar teeth condition		**DPSCs**
Karaöz Erdal in 2010 [13]	Isolation and *in vitro* characterisation of dental pulp stem cells from natal teeth	Two teeth	Two vital human natal teeth were obtained from a healthy newborn female	DPSCs	*In vitro*	sterile conditions	dental pulp	**1.Ultrastructural characteristics of hNDP-SCs showed more developed and metabolically active cells**
Yu V, Poprawa M. Damek, Nicoll, S. B. and Akintoye S.O in 2009[14]	Dynamic Hydrostatic Pressure Promotes Differentiation of Human Dental Pulp Stem Cells	four patients	Healthy premolars, without history of trauma, caries or restorations were collected after routine dental extractions performed prior to orthodontic treatment	DPSCs	Experimental study	trauma, caries or restorations free teeth	Dental pulp	**1.Direct HSP disrupts DPSC survival and odontogenic differentiation**
S. Gronthos, M. Mankani, J. Brahim, P. Gehron Robey, and S. Shi in 2000[15]	Postnatal human dental pulp stem cells (DPSCs) *in vitro* and *in vivo*	Impacted third molars	Normal human impacted third molars from adults (19–29 years of age)	DPSCs	Both *In vivo* study and *in vitro* study	Sterile conditions	Dental pulp	**1.Postnatal human DPSCs have the ability to form a dentin/pulp-like complex odontoblast**
Sunyoung Nam, Jong-EunWon, Cheol-Hwan Kim and Hae-Won	Odontogenic Differentiation of Human Dental Pulp Stem CellsStimulated by the Calcium Phosphate Porous Granules	Human dental pulps Impacted third molars	Human dental pulps collected from the third molar teeth of adult patients with ages ranging from 19-to-25 years old	DPSCs	Both *In vivo* study and *in vitro* study	Isolation and Culture properties	Dental pulp	**1.The 3D CaP porous granules should be useful for dental tissue engineering in combination with hDPSCs by providing favorable 3D substrate conditions for cell growth and odontogenic**

Kim in 2011[16]								**development**
Tatsuhiro Hidaka, Toshiyuki Nagasawa, Kaname Shirai, Takashi Kado, Yasushi Furuichi in 2012[17]	FGF-2 induces proliferation of human periodontal ligament cells and maintains differentiation potentials of STRO-1+/CD146+ periodontal ligament cells	15 HPDL tissues	15 HPDL tissues were collected from 10 extracted healthy third molars, 3 anterior teeth, 1 premolar and 1 molar, from15 subjects (mean age 32.3 yrs, range 20–61 yrs, 9 males and 6 females	DPSCs	Experimental study	Sterile conditions	Dental pulp	**1. It may be useful to culture HPDL cells with FGF-2 for the application of the human STRO-1+/CD146+ PDL cells in periodontal tissue regeneration.**
Stokowski Agnieszka, Shi, Songtao ,Sun Tao,Peter Mark, Bartold Simon Andrea Koblar , Gronthos Stan in 2007[18]	EphB/Ephrin-B Interaction Mediates Adult Stem Cell Attachment, Spreading, and Migration: Implications for Dental Tissue Repair	Impacted third molars	Normal impacted third molars from adults (18–40 Years of age) undergoing routine extractions	DPSCs and SHED	*In vivo*	Isolation techniques	DPSCs	**1.EphB/ephrin-B molecules play a role in restricting DPSC attachment and migration to maintain DPSCs within their stem cell niche**
Liu Jun, Wang Xiaodong, and Clarkson Brian H in 2012	The stimulation of adipose-derived stem cell differentiation and mineralization by ordered rod-like fluorapatite coatings	Etched stainless steel (SS) and Ti surfaces	The FA apatite films on etched stainless steel (SS) and Ti surfaces and the crystal composition, alignment, size, shape and structure are exactly the same	ASC	Both *In vivo* study and *in vitro* study	Etching technique	ASC	**1.Both the intrinsic properties of the FA crystals and the topography of the FA coating appeared to dominate the cell differentiation**

[19]								**and mineralization process.**
M. Atari *et al* in 2011[20]	Isolation of pluripotent stem cells from human third molar dental pulp	20 patients	Healthy human third molars extracted for orthodontic and prophylactic reasons from 20 different patients of different sexes and ages (14-60 years old).	DPSCs	Both *In vivo* study and *in vitro* study	Sterile conditions	Dental pulp	**1. Potent stem/progenitor cells have been isolated from normal human dental pulps.**
Raoof M *et al* in 2014[21]	A modified efficient method for dental pulp stem cell isolation	Sixty Impacted third molars	The teeth were immersed in sterile phosphate buffer saline (PBS), stored on ice pack and immediately transported to the cell culture lab for sample processing.	DPSC	*In vitro* study	PCR technique and electrophoresis	DPSC	**1. Results have shown that extracted non decayed impacted third molars are capable of producing an optimum quantity of dental pulp tissue for the isolation of DPSCs**
Hilkens P *et al* in 2014[22]	Pro-angiogenic impact of dental stem cells *in vitro* and *in vivo*	Postnatal DSCs	Angiogenic cascade, DPSCs, SCAPs and HGF-1	Postnatal DSCs	Both *in vivo* and *in vitro*	Pro-angiogenic as well as anti-angiogenic factors	DPSCs	**1.Study results suggested that DPSCs and SCAPS *in vitro* and *in vivo* in comparison to FSCs could potentially promote the vascularization of regenerated dental tissues.**
Eubanks EJ, Tarle SA, Kaigler D in 2014[23]	Tooth storage, dental pulp stem cell isolation, and clinical scale expansion without animal serum.	32 third molars	32 third molars were obtained from patients and immediately placed in saline or tissue culture medium followed by overnight storage at 4°C or immediate isolation of DPSCs	DPSCs	*In vitro*	Fetal bovine serum (FBS) or human serum (HS).	DPSCs	**1. There was no difference in the expression of CD73, CD90, CD105, or multipotency (as measured by osteogenic, adipogenic, and chondrogenic differentiation) between DPSCs in FBS and DPSCs in HS**

Schneider R *et al* in 2014[24]	**White mineral trioxide aggregate induces migration and proliferation of stem cells from the apical papilla.**	**Unsorted population of SCAP (passages 3-5)**	**Unsorted population of SCAP characterized by high CD24, CD146, and Stro-1 expression**	**Stem cells from the apical papilla**	**In viro**	**Fetal bovine serum (FBS) and calcium chloride - enriched medium were used as positive controls**	**Apical papilla stem cells**	**1.WMTA induced an early short-term migration and proliferation of a mixed population of stem cells from apical papilla as compared with a later and longer-term induction by calcium chloride or FBS**

Results

F Feng *et al* in 2010[10] conducted the retrospective pilot study to examine the feasibility and safety of reconstructing the periodontal intrabony defects with autologous periodontal ligament progenitor (PDLP) implantation and found that transplantation of PDLPs may provide therapeutic benefit for the periodontal defects and all treated patients showed no adverse effects during the entire course of follow up and also found that PDLPs were analogous to PDLSCs in terms of high proliferation, expression of mesenchymal surface molecules, multipotent differentiation, and *in vivo* tissue regain.

Su-Hwan Kim *et al* in 2011[11] conducted the study to compare the gene expression profile in mesenchymal stem cells derived from dental tissues and bone marrow for characterization of dental stem cells and identified 379 up-regulated and 133 down-regulated transcripts in BMSCs, 68 up-regulated and 64 down-regulated transcripts in PDLSCs, and 218 up-regulated and 231 down-regulated transcripts in DPSCs

Khanna Jain Rashi *et al* in 2012 [12] conducted the study to identify suitable cell culture media alternatives for DPSCs and said that proliferation of DPSCs was significantly lower in SF/XF-M when compared with cells cultured in FBS-M and HS-M. There were differences in osteogenic, chondrogenic and adipogenic differentiation efficacy between cells cultured in FBS, HS and SF/XF differentation media and HS is a suitable alternative to FBS for the expansion of DPSCs.

Erdal Karaöz *et al* in 2010[13] conducted the study to isolate and extensively characterize SCs derived from human natal dental pulp and indicated that ultrastructural characteristics of hNDP-SCs showed more developed and metabolically active cells. hNDP-SCs and hBM-MSCs expressed some adipogenic, myogenic , neurogenic, osteogenic and chondrogenic markers without any stimulation towards diverentiation under basal conditions.

Yu V, Poprawa M. Damek, Nicoll S. B, and Akintoye S.O. in 2009 [14]did study and find out that the masticatory apparatus absorbs high occlusal forces, but uncontrolled parafunctional or orthodontic forces damage periodontal ligament (PDL), cause pulpal calcification, pulp necrosis and tooth loss and direct dynamic hydrostatic pressure (HSP) disrupts DPSC survival and odontogenic differentiation.

Gronthos S , M. Mankani, Brahim J , Robey P. Gehron , and Shi S in 2000 [15] studied that dentinal repair in the postnatal organism occurs through the activity of specialized cells, odontoblasts and postnatal human DPSCs have the ability to form a dentin/pulp-like complex odontoblast.

Nam Sunyoung, EunWon Jong , Kim Cheol-Hwan and Won Kim Hae in 2011 [16] conducted a study to know the effects of three-dimensional (3D) calcium phosphate (CaP) porous granules on the growth and odontogenic differentiation of human dental pulp stem cells (hDPSCs) for dental tissue engineering and found that the 3D CaP porous granules should be useful for dental tissue engineering in combination with hDPSCs by providing favorable 3D substrate conditions for cell growth and odontogenic development.

Hidaka Tatsuhiro, Nagasawa Toshiyuki, Shirai Kaname, Kado Takashi, Furuichi Yasushi in 2012 [17]conducted a study where human PDL cells were individually prepared from extracted teeth and cultured with or without FGF-2 and found that FGF-2 augmented the proliferation of the STRO-1+/CD146+ cells in the HPDL cultures. Thus, it may be useful to culture HPDL cells with FGF-2 for the application of

the human STRO-1+/CD146+ PDL cells in periodontal tissue regeneration.

Stokowski Agnieszka, Shi Songtao, Sun Tao, Bartold Peter Mark, Simon Andrea, Koblar Stan Gronthos in 2007 [18] conducted a study to examine the expression and function of the B-subclass Eph/ephrin molecules on DPSCs, suggest that EphB/ephrin-B molecules play a role in restricting DPSC attachment and migration to maintain DPSCs within their stem cell niche under steady state conditions and may have implications for dental pulp development and regeneration.

Liu Jun, Wang Xiaodong, and Clarkson Brian H in 2012 [19] conducted a study to know the effect of ordered rod-like FA coatings of metal discs on adipose-derived stem cell (ASC)'s growth, differentiation and mineralization was studied *in vitro*; and their mineral inductive effects *in vivo* and found that both the intrinsic properties of the FA crystals and the topography of the FA coating appeared to dominate the cell differentiation and mineralization process.

M. Atari *et al* l in 2011 [20] did study that potent stem cells have been isolated from normal human dental pulps and by using a 3D culture system, DPPSCs are able to differentiate into both endoderm and mesoderm tissues and after culture in bone differentiation medium, DPPSCs can gave rise to bone-like tissue that is able to synthesize typical structures, such as collagen and cortical structures.

Raoof M *et al* in 2014 [21] did *in vitro* study and said that dental pulp stem cells were isolated by the following three different methods: (1) digestion of pulp by collagenase/dispase enzyme and culture of the released cells; (2) outgrowth of the cells by culture of undigested pulp pieces; (3) digestion of pulp tissue pieces and fixing them and the results indicated that by the first method a few cell colonies with homogenous morphology were detectable after 4 days, while in the outgrowth method more time was needed (10-12 days) to allow sufficient numbers of heterogeneous phenotype stem cells to migrate out of tissue. Interestingly, with the improved third method, we obtained stem cells successfully with about 60% efficiency after 2 days.

Hilkens P *et al* in 2014 [22] conducted a study with an aim to elucidate the paracrine angiogenic properties of postnatal DSCs, in particular dental pulp stem cells (DPSCs), stem cells from the apical papilla (SCAPs) and dental follicle precursor cells (FSCs). An antibody array, together with RT-PCR and ELISA, pointed out the differential expression of pro-angiogenic as well as anti-angiogenic factors by cultured DSCs and human gingival fibroblasts (HGF-1) and indicate a predominant pro-angiogenic influence of DPSCs and SCAPS *in vitro* and *in vivo* in comparison to FSCs, suggesting that both stem cell populations could potentially promote the vascularization of regenerated dental tissues.

Eubanks EJ, Tarle SA, Kaigler D *et al* in 2014 [23] did study on 32 third molars which were obtained from patients and said that the time frame of storage and storage medium did not affect the ability to isolate DPSCs and there was no difference in the expression of CD73, CD90, CD105, or multipotency (as measured by osteogenic, adipogenic, and chondrogenic differentiation) between DPSCs in FBS and DPSCs in HS.

Schneider R *et al* in 2014 [24] did study and used an unsorted population of SCAP (passages 3-5) characterized by high CD24, CD146, and Stro-1 expression and assessed the effect of WMTA on SCAP migration by using transwells, and its effect on proliferation was determined by the WST-1 assay and demonstrate that WMTA induced an early short-term migration and proliferation of a mixed population ofstem cells from apical papilla as compared with a later and longer-term induction by calcium chloride or FBS.

Discussion

The present review describes the potentially life-saving therapies derived from a patient's own stem cells located in deciduous and permanent teeth, the identification of several types of epithelial and mesenchymal pluripotent cells and by using *in vivo* and *in vitro* experiments generation of a complete tooth with all dental structures including cells and extracellular matrix deposition. Some studies shown that the development of genome wide research techniques describing and comparing the gene expression patterns of different cells and understand the mechanisms governing the display of each cell's characteristics. There are some reports showing the effects of serum free or low serum containing media on DPSCs cultures and to safely produce DPSCs for clinical applications, evaluated the response of FBS, HS or SF/XF media on isolation, expansion, morphology, phenotype, growth and multilineage differentiation potential of DPSCs .[12] DPSCs isolated from orthodontic patients was adequate to demonstrate statistically significant cellular response in mesenchymal stem cells from a semi-homogeneous group.[14] Gronthos *et al*. studied that human dental pulp stem cells can develop into odontoblasts and form the mineralised matrix of dentin.[13] The introduction of scaffolds/matrices is also of crucial importance for the successful use of stem cells in defective sites. A variety of inorganic biomaterials, such as calcium

hydroxide mineral trioxide aggregates, have been used during the repair of dental tissues targeting pulp capping and dentin remineralization. Some recent studies have shown the potential of 3 dimensional (3D) matrices for use in the odontogenic regulation of DPSCs. However, most studies have mainly employed 2D culture of DPSCs to identify regulatory factors and to control proliferative and differentiation behavior. When compared to the 2D culture condition, the 3D matrix may significantly alter stem-cell behavior such as initial growth and matrix synthesis of the target tissues. Moreover, the specific use of CaP bioactive materials for the regeneration of dentin-pulp complex is considered to be useful as an alternative therapy in DPSCs-based dental tissue engineering. [16] Eubanks EJ *et al* did study on 32 third molars which were obtained from patients and said that the time frame of storage and storage medium did not affect the ability to isolate DPSCs. [23] some authors said that stem cells can successfully isolate with 60% efficiency after 2 days by digestion of pulp tissue pieces and fixing them and some suggesting that stem cell populations could potentially promote the vascularization of regenerated dental tissues.[21,22]Previouslydemonstrated that human DPSCs have the capacity to regenerate organized tooth-like structures when transferred subcutaneously. Recently, Tecles *et al* in 2007 confirmed that odontogenic precursor cells could be mobilized from their perivascular niche to sites of injured pulp or dentine tissue. However, the mechanisms responsible for the recruitment and differentiation of DPSCs have yet to be defined. [18]

Conclusion

Medical research is endlessly exciting, by its very nature, continuously uncovering new facts and principles that build upon existing knowledge to modify the way we think about biological processes. The field of pluripotent cell-based regenerative dentistry is complex and multidisciplinary by nature and pluripotent cell research offers an amazing potential for body homeostasis, repair, regeneration and pathology. Dental stem cells show a promising role in regenerative therapy especially for pulpal and periodontal therapy. But the progress will depend on the collaboration between clinicians and researchers from diverse fields. Pluripotent cell-based dental tissue regeneration is a new and exciting field that has the potential to transform the way that we practice dentistry. The present systematic review reveals that Dental stem cell research is not merely a science fiction but has rather opened the door for future treatment modalities. Further longitudinal researches are recommended to understand and comment on the success of dental stem cells with conformity.

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