Abstract: Dental SCs have drawn attention in recent years because of their accessibility, plasticity, and high proliferative ability. Several types of dental SCs have been identified, including dental pulp SCs from adult human dental pulp, SCs from human primary exfoliated deciduous teeth, periodontal ligament SCs, and dental follicle SCs from human third molars. Similar to mesenchymal SCs, these dental SCs can undergo self-renewal and have multipotent differentiation ability. Therefore, appropriate preservation procedures for dental SCs and teeth are now needed. Here, we discuss the opportunities for tooth-banking (as it is now clinically feasible and commercially available), the advantages and limitations of current cryopreservation techniques for dental SCs/teeth or tissues, and the current status of tooth banks.

Keywords: cryopreservation, stem cells, tooth banking.

INTRODUCTION
The source for banking smiles is the small wonders of our body, the stem cells! Stem cells are powerful & unique cells that can multiply several times & depending on the surrounding can form specific desired tissue or organ. This has the potential to provide solutions for several incurable diseases or injuries.

Stem cell research is directed towards perfect the art of using one’s cell to repair that part of the body which has become affected due to particular disease. Stem cells can now be harvested, made to multiply, stored & utilized whenever required in future. This is similar to the practice of banking where one deposits money, multiplies it, stores it for use later; thus known as Stem cell banking.
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- Capable of dividing and renewing stem cells, Stem cells found in Amniotic Fluid – themselves for long periods without differentiating
- Not fully specialized
- Can give rise to specialized cells(fig.1)

**Fig.1:** Figure showing origin of stem cells.

### Role of stem cells

Stem cells, by virtue of their properties are the key players in the creation and maintenance of our body. They play an important role in maintaining & repairing normal & diseased organs.

**Sources**
- Embryonic/ fetal stem cells
- Adult/post natal stem cells
- Umbilical cord
- Amniotic fluid

**Adult/ Post natal stem cells (fig.2)**
- Found in adult tissue.
- Can self-renew many times.
- These are multipotent – they can differentiate to become only the types of cells in the tissue they come from.

Examples : Hematopoietic stem cells – give rise to blood cells, Mesenchymal stem cells – give rise to cells of connective tissues and bones, Umbilical cord stem cells – a rich source of hematopoietic

**Fig.2:** Figure showing stem cell sources.

- Derived from Embryos
- Can Self Renew
- These are pluripotent- they can differentiate to become almost every cell in the body.

### Sources of Stem cells from Teeth

In 2000, Gronthos et al. isolated the first MSC like cells from the human dental pulp. Subsequently, four more types of MSC-like cells have been isolated from dental tissues: pulp of exfoliated deciduous teeth, PDL, apical papilla and dental follicle.

#### Dental Pulpal Stem Cells (DPSCs)

DPSCs were the first type of dental stem cells to be isolated. These cells were obtained by enzymatic digestion of the pulp tissue of the human impacted third molar tooth.

**Fig.3:** Figure showing DPSC differentiation

Dental Pulp Stem Cells or (DPSCs) are multipotent stem cells that have the potential to differentiate into a variety of cell types. Ability to regenerate a Dentin-pulp-like complex in an arrangement similar
to the dentin-pulp complex found in normal human teeth. Contain multipotent neural crest stem cells (NCSC).

**Periodontal Ligament Stem Cells (PDLSCs)**
The PDL does not only anchor the tooth, but also contributes to its nutrition, homoeostasis, and repair. PDL contains different types of cells including cells which can differentiate into cementoblast and osteoblasts. PDL contains STRO-1 positive cells that maintain certain plasticity since they can adopt adipogenic, osteogenic and chondrogenic phenotypes in vitro. PDLSCs have the potential for forming periodontal structures, including the cementum and PDL.

**Stem Cells from Human Exfoliated Deciduous teeth (SHED)**
In 2003, Miura et al. isolated cells from the dental pulp which were highly proliferative and clonogenic. SHEDs unlike DPSCs, have an osteoinductive potential rather than a differentiation potential. Exfoliated deciduous tooth houses living pulp remnants consisting of connective tissue, blood vessels, and odontoblasts. 12 to 20 cells from each exfoliated incisor formed adherent colony clusters with extensive proliferative capacity.

**Dental Follicle Precursor Cells (DFPCs)**
The dental follicle (DF), is a loose connective tissue of an ectomesenchymal origin and it is present as a sac surrounding the unerupted tooth. In 2005, Morsczeck et al. were successfully able to isolate stem cells from the dental follicle of the human impacted third molar. DF differentiates into the periodontium as the tooth is erupting and becomes visible in the oral cavity.

**Stem Cells of Apical Papilla (SCAPs)**
During tooth development, the dental papilla evolves into the dental pulp, and contributes to the development of the root. In 2006, Sonoyama et al. isolated a new population of dental stem cells, and called them SCAPs. SCAPs have the capacity to undergo osteogenic, adipogenic, chondrogenic and neurogenic differentiation.

With advances in tissue engineering, dental SCs have shown their potential in regenerating odontoblasts, dentin/pulp-like structure, and dentin. Furthermore, dental SCs can differentiate into adipocytes and neurons, and promote the proliferation and differentiation of endogenous neural cells. It is also possible that myocardial infarction and liver dysfunction could be treated with dental SCs in the near future. Thus, the therapeutic capability and clinical benefits of dental SCs are not limited to dental use but can also be used for regenerative medicine.

Because of the opportunity to preserve dental SCs for medical applications, the term “tooth bank” was first raised in 1966. With the rapid development of advanced cryopreservation technology, the first commercial tooth bank was established as a venture company at National Hiroshima University in Japan in 2004.

**The Science Of Stem Cell Banking**

**Stem Cell Cryopreservation**
The practice of cryopreserving and later using cells for clinical use is well established. Bone marrow, cord blood, and fertilized embryos have been routinely preserved for decades. For example, cord blood began being preserved for clinical use immediately after its potential for therapeutic use was reported and has successfully been recovered from long term storage. Therefore, the
cryopreservation of dental stem cells simply represents the application of existing technology to a new source of stem cells. In fact, commercial dental stem cell banking services are now available.

**Procedure** – After the tooth or teeth sample is collected by the dentist, the sample is transported from the dentist office to the laboratory. Cells should be transported in a sterile, isotonic solution, shipped chilled to reduce the growth of contaminating microbes, and delivered to the laboratory as quickly as possible.

Cryopreservation involves equilibrating the cells with a cryoprotectant solution—a solvent that protects the cells from the formation of ice crystals and that helps preserve the integrity of cell membranes upon thawing. The temperature is typically slowly brought down to freezing using programmable controlled-rate freezers. Frozen cells are then transferred to vapor-phase liquid nitrogen freezers for long-term storage at ultra-low temperatures, typically at about -150°C.

Current scope of stem cells in dentistry

1. In continued root formation
2. In pulp healing and regeneration
3. In replantation and transplantation
4. Pulp dentin tissue engineering & regeneration

**Benefits of dental stem cells**

1. Increasing the success rate of tooth autotransplantation.
2. Better proliferation and immuno-regulation than bone marrow-derived Mesenchymal Stem Cells.
3. Dental stem cell-based tissue engineering
   - Oral medicine
   - Tooth regeneration
   - Pulp/dentin regeneration
   - Periodontal ligament regeneration
4. Other medical application
   - Bone formation
   - Stroke therapy
   - Heart disease
5. Efficient and easy to access source of MSCs
6. Potential for commercial banking

Commerncially available tooth banks

1. Store-A-tooth – Provia Laboratories
2. Stemade Biotech– banking smiles- Institut Clinident Biopharma
3. Store your cells- USA
4. Stem Save
5. BioEden- Austin, Texas

**CONCLUSION**

Research has shown that teeth are a source of high quality stem cells that may be used for the treatment of medical and dental disease. The discovery that
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odontogenic tissues are a source of adult stem cells has opened up a new role for dentists in the field of medicine. Dentists are positioned to become one of the key providers of stem cells, and as a result, their linkage with the medical field will become very intimate.

Dental stem cells have the potential to be used in the treatment of a full range of oral pathoses. Dentists can be involved in the extraction, collection, and storage of the stem cells from their patients’ teeth. Ongoing research suggests that these stem cells will soon be used for dental purposes such as to replace lost bone around teeth, periodontal ligament or dental pulp; treat periodontal disease; and someday even produce new teeth, as well as for medical applications.

In order for dentists to fully participate in this new role, they should become aware of the applications, clinical use, and banking of dental stem cells.

REFERENCES


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