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IMPORTANCE OF STEM CELLS IN DENTISTRY

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ABSTRACT

Stem-cells are primitive cells which are present in different parts of the body such as bones, umbilical cord, placenta, embryo, teeth etc. For years scientists all over the world have been working on possibilities of using these Stem-cells to regenerate human cells which are damaged due to illness, developmental defects and accidents. In fact, stem-cells can create replacement cells for those that are lost or damaged by injury or disease.

Key words **Stem-cell, Embryonic Stem-cells, Adult Stem-cells, Chondrocytes, Osteoblasts, Adipocytes, Mesenchymal Stem-cells.**

INTRODUCTION

The term Stem-cell was proposed for scientific use by Russian histologist Alexander Maksimov in 1908[1]. While research on stem cells grew out of findings by Canadian scientists in the 1960s.In general there are two broad types of Stem-cells [1-3]:

- Embryonic stem- cells
- Adult Stem-cells.

Embryonic Stem-cells

These cells are taken from a developing egg which is fertilized in Laboratory. These Cells can create all body cells. Cells are numerous, easily attained, multiply easily in culture.

Adult-Stem cells

These cells are also called as somatic Stem-cells because they refer to body cells, not sperm or egg.Cells can renew themselves and develop into related tissue where they reside. The number of cells are limited and difficult to get large numbers**. (Fig.1.)**

Stem-cells can divide and change into particular required type of cells, which under controlled conditions, can grow into organs, bones and tissue, or developed Stem-cells can work on repairing the immune system. In fact, stem-cells can create replacement cells for those that are lost or damaged by injury or disease .Tooth Stem-cells are found in the deciduous (baby teeth or milk teeth) of children and third molar teeth(wisdom teeth) of adults. Recent studies show that deciduous teeth and third molar teeth Stem-cells appear to have the ability to develop into more types of body tissue than other types of Stem- cells. Hence this difference opens the door to more therapeutic applications. Stem-cell therapy is emerging as a revolutionary new way to treat disease and injury, with wide-ranging medical benefits. It works by introducing Stem-cells into an area where the normal cells have lost their function due to disease or damage.

The Stem-cells then replace or repair the damaged cells and restore normal function. Hence proper preservation of a child's deciduous teeth just before shedding and third molar teeth immediately after extraction in adults, Stem-cells will be available ready for use, needed in the future to treat a disease or repair an injury.

What are Stem -cells?[2,3]

- Un specialized cells
- Give rise to more than 250 specialized cells in the body
- Serve as the body's repair system –renew themselves, replenish other cells.

Sources Of Stem-Cells [1-7]

In the early stages of Stem cell research, bone marrow was the sole source. Since then a number of other sources have been found to contain Stem cells.

- Bone marrow Stem cell usually comes from the long bones. The best sources are pelvic bones, femur and sheen bone.
- Umbilical cord blood Stem-cells are obtained from the umbilical cord blood, which are collected just after the birth of the baby.
- Embryonic cells are obtained from the blastocyst phase of the embryo. Cells are highly efficient in producing newer types of cells.
- Placental Stem-cells provide almost all the life supports to keep a baby alive. After birth it has been found to give rise to more number of Stem-cells as compared to embryonic Stem-cells.
- Menstrual Stem-cells have an extra-ordinary improvement over the umbilical cord blood cells. They have a rapid growth rate.
- Dental Stem-cells are cells obtained from the pulp of deciduous or wisdom teeth. This has been found to produce bones, cartilage, and muscle cells if cultured.
- Stem cells are also present in natal teeth, mesiodense or supernumerary teeth.

Stem Cells in Dentistry[8]

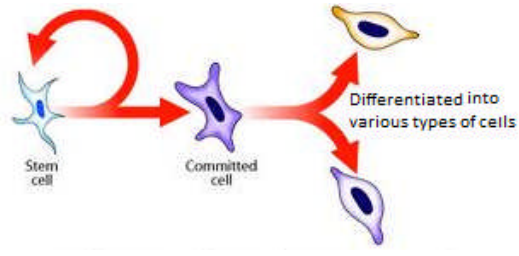
2000- Discovery of adult Stem-cells in dental pulp cells, the living tissue at the centre of tooth.
2003- Stem-cells found in baby teeth.
2004- Stem-cells found in periodontal ligament, which holds the teeth in place in gums.
2007- Researchers learn how to reprogram some adult cells from mice to assume a State like Embryonic Stem-cells called induced pluripotent Stem-cells.
2008- Cells in dental pulp identified as adult Stem-cells.

In the year 2003 Dr. Songtao Shi who is a paediatric dentist discovered baby tooth Stem-cells by using the deciduous teeth of his six year old daughter, he was luckily able to isolate, grow and preserve these Stem cells with regenerative ability, and he named them as SHED (Stem-cells from Human Exfoliated Deciduous teeth). After the scientists studied the dental pulp looking for Stem-cells they found that the dental pulp was rich in different Stem-cell types such as:

Chondrocytes: which are Stem-cells that have the ability to regenerate cartilage and these cells play an important role in the treatment of arthritis and joint diseases.

Osteoblasts: They are Stem-cells that have the ability to regenerate bone.

Adipocytes: Another type of stem-cells that have the ability to repair damaged cardiac tissues following a heart attack.



Stem Cell	Cell plasticity
Totipotent	Each cell can develop into a new individual
Pluripotent	Cells can form any(>200) cell types
Multipotent	Cells differentiated but can form a number of other tissues

Fig.1. Lineage of cell population

Mesenchymal Stem Cells: Those are the most potent among all tissue Stem-cells and have the ability to differentiate into various types of reparative cells. In general Mesenchymal Stem-Cells are non-haematopoietic stromal cells capable of differentiating into a range of cells, those cells were first discovered in bone marrow and they were noticed to have the ability to double into many populations without loss of function, they also have the so called homing property which means that when they are delivered systemically they migrate to the site of injury. So it is to say that MSC (mesenchymal Stem cells) are more promising for therapeutic applications than other types of Stem-cells. **(Fig.2.)**

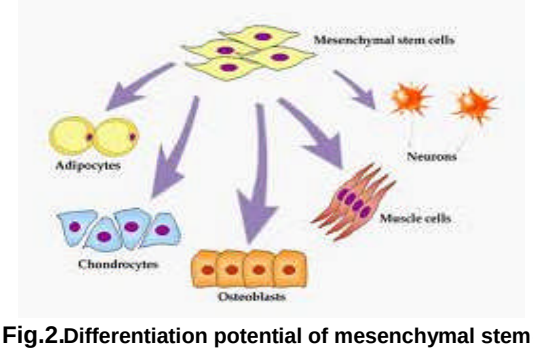


Fig.2.Differentiation potential of mesenchymal stem-cells

Recently Stem cell banks are present, and even some of these banks do not only freeze cord Stem cells but also dental Stem-cells of baby teeth. This can be done easily when a child's anterior milk tooth is shedding, the tooth is extracted by the dentist and preserved in a special kit provided from the Stem-cell bank company who then in their turn transfer the tooth to their special labs to harvest the dental Stem-cells and store them in their bank for each child confidentially until they are needed later for the child himself or a member of his family.

Mesenchymal Stem-cells have more therapeutic potential than any other type of adult Stem-cells.

Process of stem-cell collection[4,5]

It is a three step process which is simple, effective and non-invasive **(Fig.3)**

Step 1: Tooth Collection	child's tooth is extracted with utmost care and placed it in the storage container along with frozen gel packs. The kit is then ready for delivery to lab.
Step 2: Stem Cell Isolation	In the lab the current health and viability of these cells is determined.
Step 3: Tooth Cell Storage	Then they are cryo preserved for future use. The cells are preserved in liquid nitrogen vapour at a temperature of less than -15 degree centigrade. This preserves the cells and maintains their potential potency.

The first 48 hours after the tooth is out of the mouth are critical. The tooth must be prepared, packaged and shipped and received at laboratory during this time to maximize a successful isolation. The most important contribution you can make to the success of this process is to be prepared in advance for the next time when child's tooth or wisdom tooth becomes loose.

Potential Application of Stem-Cell Therapy In Dentistry

The regenerative potential of Adult Stem-cells obtained from various sources including dental tissues has been of interest for clinicians over the past years and most research is directed toward achieving the following:

- Regeneration of damaged coronal dentin and pulp
- Regeneration of resorbed root, cervical or apical dentin, and repair perforations
- Periodontal regeneration
- Repair and replacement of bone in craniofacial defects
- Whole tooth regeneration

Clinical Applications Of Stem-Cell Therapy[7,8]

Medicine continues to move rapidly towards personalised treatment for a host of diseases, and Stem-cell therapy is one way to shift the move into high gear. Stem-cell therapy treats diseases by replacing dysfunctional or diseased cells with healthy, functioning ones. In fact Stem-cell research is the most promising path to curing many severe diseases and disabling medical conditions that would otherwise remain untreatable. For Stem cell therapy to work however, it is imperative that the source of the Stem-cells be compatible with the recipient. To avoid the rejection of transplanted tissues it is best to use the patient's own cells for these treatments. This is called an autologous transplant. General cell banking or transferring cells between close relatives does not have nearly as high an acceptance rate as the use of personal (autologous) cells. There are many types of Stem-cell therapy and it is becoming a common treatment for some conditions.

Step 1: Tooth Collection

Step 2: Stem Cell Isolation

Step 3: Tooth Cell Storage

Fig.3. Steps in stem cell collection

Source: https://869789182725854870-a-drswarups-com-s-sites.googlegroups.com/a/drswarups.com/www/dental-stem-cell-banking-at-dr-swarup-s/tooth-cells-bank4.jpg

Stem-cell therapy has been accepted as the effective treatments for many blood diseases, certain types of Cancers and several other diseases in the U.S. , over the last 10 years and it has been used much more frequently in other countries around the world. It is believed that Stem-cell therapy may eventually offer remedies for Brain diseases such as Stroke, Parkinson's and Alzheimer's diseases, Spinal cord injury, Autoimmune diseases, Mitral stenosis, Osteoarthritis, Degenerative diseases, and certain forms of Cancer and Heart disease.

One of the most important potential applications using this material is for the treatment of paralysis due to spinal cord injury which has already been done using Mesenchymal stem cells from other sources. Storing these cells for yourself and your child is an excellent way to ensure your and your child's future biological needs in case of disease or injury.

CONCLUSION

Stem-cells derived from all sources hold immense medical promises. Stem-cell therapies have virtually unlimited medical and dental applications. We have moved on from the surgical model of care to the medical model and are likely to move onto the biological model of care. The need of the hour is high-quality research coupled with collaboration between basic scientists and the clinicians. A team effort engaging the expertise of the molecular biologists, immunologists, biomaterial scientists, cell biologists, matrix biologists, and practicing dental surgeons is crucial in attaining the desired goal. Stem-cell therapy is no longer science fiction.

Recent developments in the technique of Stem cell isolation and expansion together with advances in growth factor biology and biodegradable polymer constructs have set a stage for successful tissue engineering of tooth/tooth-related tissues. Stem-cell therapy has brought in a lot of optimistic hope amongst researchers, doctors, and not to forget the patients who are the chief beneficiary of this innovation. Stem-cells regenerate hope and not all that is happening in research is hype.

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