

6.Stem Cell Therapy

Researchers At Osaka Metropolitan University Have Developed a New Technique to Heal Spinal Fractures Using Adipose-Derived Stem Cells (Adscs)

Osteoporosis Overview

Definition & Nature of Disease – Osteoporosis Is a Systemic Skeletal Disorder Characterized by Reduced Bone Mineral Density (Bmd) And Deterioration of Bone Microarchitecture. This Increases Bone Fragility and Susceptibility to Fractures, Especially in The Spine, Hip, And Wrist.

Global & Japan-Specific Burden – Affects Over 200 million People Worldwide, Most Commonly Postmenopausal Women and Older Adults. In Japan, nearly 15 million People Suffer from Osteoporosis, Driven By –

1. Rapid Population Ageing
- 2.Low Dietary Calcium Intake
- 3.Longer Life Expectancy

Japan Represents One of The Fastest-Ageing Societies Globally, Making Osteoporosis A Rising Public Health Challenge.

Vertebral Compression Fractures (Vcfs)

Most Common Osteoporotic Injury – Vcfs Occur When Weakened Vertebrae Collapse, Usually Under Minor Stress or No Trauma. They Account for Over 700,000 Cases Annually Worldwide.

Clinical Impact – Often Underdiagnosed Because Symptoms May Be Mild or Mistaken for Back Strain. Can Lead To –

1. Chronic Back Pain
- 2.Spinal Deformity (Kyphosis)
3. Reduced Height
4. Increased Risk of Further Fractures
5. Impaired Mobility and Reduced Quality of Life

High Socioeconomic Burden – Leads to Long-Term Care Needs, Hospitalization Costs, And Productivity Losses in Elderly Populations.

Limitations Of Current Treatments

Vertebroplasty – Injection of Bone Cement into The Collapsed Vertebra for Stabilization.

Limitations –

1. Risk of Cement Leakage
2. No Restoration of Vertebral Height.
3. Pain Relief Not Guaranteed

Kyphoplasty – Balloon Inserted into Vertebra to Restore Height Before Injecting Cement.

Limitations –

1. Expensive and Invasive
2. Risk of Adjacent-Level Fractures

Metallic Implants / Spinal Fixation – Used in Complex Fractures Requiring Stabilization.

Limitations –

1. Highly Invasive
2. Risk of Infection or Hardware Failure
3. Not Ideal for Older Patients with Poor Bone Quality

Overall Conclusion – Current Treatments Manage Symptoms but Do Not Regenerate Bone, Prompting Global Interest in Stem Cell-Based Regenerative Therapies.

Stem Cells

Definition – Stem Cells Are Undifferentiated Cells with The Unique Ability To –Self-Renew (Make Identical Copies), Differentiate into Specialized Cells (Bone, Cartilage, Nerve, Muscle), They Form the Backbone of Regenerative Medicine, Treating Diseases Where Tissues Degenerate or Fail to Repair Naturally.

Types Of Stem Cells

Embryonic Stem Cells (Escs) – Pluripotent Cells Capable of Forming All 200+ Cell Types in The Human Body. Derived From Blastocyst-Stage Embryos. Strengths – Highest Regenerative Potential, Stable Growth. Challenges –

1. Ethical Issues Due to Destruction of Embryos
2. High Tumorigenicity (Risk of Teratoma Formation)
3. Strict Government Regulations Worldwide

Adult (Somatic) Stem Cells – Found in Tissues Like Bone Marrow, Skin, Liver, Adipose Tissue, And Blood.

Multipotent, Meaning They Differentiate Only into A Limited Set of Cells. Natural Role – Repair and Maintenance of Specific Tissues. Advantages – Fewer Ethical Concerns. Limitations – Lower Proliferation and Regenerative Ability Compared to Escs.

Induced Pluripotent Stem Cells (Ipscs) – Adult Cells Genetically Reprogrammed to Behave Like Escs. Pluripotent Like Escs Without Ethical Issues.

Uses –

1. Disease Modelling
2. Personalized Drug Testing
3. Regenerative Therapies

Limitations –

1. High Cost
2. Risk Of Genetic Instability
3. Potential Tumor Formation

Mesenchymal Stem Cells (Mscs) – A Specialized Subset of Adult Stem Cells Found In –

1. Bone Marrow
2. Adipose Tissue
3. Dental Pulp
4. Umbilical Cord

Multipotent Cells Capable of Forming –

1. Bone (Osteocytes)
2. Cartilage (Chondrocytes)
3. Fat (Adipocytes)

Widely Researched in Bone Regeneration, Arthritis, Spinal Repair, And Tissue Engineering.

Adipose-Derived Stem Cells (Adscs)

Source & Characteristics – Derived from Body Fat, Collected Through Liposuction.

Represent 2–3% Of Cells in Adipose Tissue—High Compared to Bone Marrow Stem Cells (<0.01%).

Adscs Retain Properties of Mscs but Are Easier, Safer, And Cheaper to Collect, Even in Older Patients.

Advantages In Regenerative Medicine

Ease Of Harvesting – Fat Extraction Through Liposuction Is Minimally Invasive, Unlike Bone Marrow Aspiration.

High Proliferation – Adscs Multiply Faster and More Efficiently, Making Them Suitable for Large-Scale Therapies.

Suitability For Elderly Patients – Elderly Individuals Often Have Lower Bone Marrow Stem Cell Counts.

Adscs Maintain Good Regenerative Potential Even with Age.

Bone & Cartilage Repair Potential – Adscs Can Differentiate into Osteoblasts and Chondrocytes, Making Them Ideal for Osteoporosis-Related Fractures and Spinal Damage.

Natural Healing Promotion – Adscs Secrete Growth Factors and Cytokines That –

- 1.Reduce Inflammation
2. Stimulate Angiogenesis (New Blood Vessels)
3. Activate Bone-Forming Genes
- 4.Enhance Collagen Formation

Potential Cost Savings – May Reduce Long-Term Reliance on Implants, Repeated Surgeries, And Hospitalizations.

Concerns & Challenges of Adsc Therapy

Scientific Limitations – Most Evidence Is from Animal Models; Robust Human Trials Are Still Ongoing.

Long-Term Safety, Cell Stability, And Durability of Therapeutic Effects Remain Uncertain.

Biological Risks – Risk Of – Uncontrolled Cell Growth Leading to Tumour Formation. Immune Reactions.

Genetic Mutations During Cell Expansion. Poor Survival of Transplanted Cells in Damaged Tissue

Regulatory & Ethical Challenges

Need For – Standardized Protocols, Long-Term Monitoring Mechanisms, Clear Ethical Guidelines for Manipulation of Human Cells. Different Countries Have Varying Laws for Stem Cell Therapies, Complicating Global Research Collaboration

Future Prospects – Adscs Combined With 3d Scaffolds, Biomaterials, And Gene Editing (Crispr) May Revolutionize Treatment For – Osteoporosis-Related Fractures, Spinal Disc Degeneration, Osteoarthritis, Chronic Bone Defects. Expected To Shift Care from Symptom Management to True Biological Regeneration.

Source - <https://timesofindia.indiatimes.com/City/Bhubaneswar/Centre-Working-On-Stem-Cell-Therapy-Genetic-Solutions-For-Diabetes-Minister/ArticleShow/125303457.Cms>

