Adipose Mesenchymal Stem Cell

- Optimizing mesenchymal stromal cells priming strategies for tailored effects on the secretome
- Polylactic Acid/Polyvinylpyrrolidone Scaffolds With Adipose Tissue-Derived Mesenchymal Stem Cells Enhance Nerve Regeneration in Rats
- Intranasal delivery of engineered extracellular vesicles promotes neurofunctional recovery in traumatic brain injury
- Pineal Region Angiolipoma Resection by Supracerebellar Infratentorial Endoscopic Approach: A Case Study
- The therapeutic potential of mesenchymal stromal cell secretome in treating spontaneous chronic corneal epithelial defects in dogs
- Immunomodulation effects of collagen hydrogel encapsulating extracellular vesicles derived from calcium silicate stimulated-adipose mesenchymal stem cells for diabetic healing
- Early activation of macrophage-2 with IL-4 in stromal vascular fraction increases VEGF levels and adipocyte count and maintains volume of fat graft in Wistar rats (Rattus norvegicus)
- Superoxide dismutase 2 deficiency in mesenchymal stromal cells induces sympathetic denervation and functional impairment of brown adipose tissue

Adipose Mesenchymal Stem Cells (ADSCs) are a type of multipotent stem cell found in adipose (fat) tissue. They are a subset of mesenchymal stem cells (MSCs), which are known for their ability to differentiate into various cell types, including osteocytes (bone cells), chondrocytes (cartilage cells), adipocytes (fat cells), and neurons, among others. ADSCs have garnered significant attention in regenerative medicine due to their accessible and abundant source, as well as their regenerative potential.

Key Characteristics of ADSCs:

1. **Multipotency**: Like other MSCs, ADSCs can differentiate into a variety of cell types, including osteoblasts (bone), chondrocytes (cartilage), adipocytes (fat), and neural cells. This makes them promising for tissue repair and regeneration.

2. **Self-renewal**: ADSCs can replicate and maintain their stem cell characteristics over extended periods, making them suitable for use in long-term therapies.

3. **Immunomodulatory Properties**: ADSCs are known for their ability to modulate the immune response, which can help reduce inflammation and promote healing in tissue repair. This is particularly beneficial in preventing immune rejection when used in therapies for injured or diseased tissues.

4. **Secretion of Growth Factors**: ADSCs can secrete various bioactive molecules, including growth factors and cytokines, which promote tissue repair, cell migration, and angiogenesis (the formation of new blood vessels). These properties make them valuable in tissue engineering and regenerative therapies.

5. **Easier Harvesting**: ADSCs are obtained from adipose tissue, which can be harvested through a relatively simple, minimally invasive procedure (liposuction), making them more accessible and less invasive compared to other stem cell sources like bone marrow.

Applications in Regenerative Medicine:

ADSCs have shown promise in a variety of therapeutic areas, particularly in regenerative medicine and tissue engineering:

1. **Neural Repair**: ADSCs have been explored for their ability to support peripheral nerve regeneration. They can differentiate into neural-like cells, and their secreted factors may help promote nerve growth and repair. In studies like the one you referenced, ADSCs are used in combination with other materials (like chitosan or acellular matrices) to create grafts for repairing nerve injuries.

2. **Bone and Cartilage Regeneration**: ADSCs can differentiate into osteoblasts and chondrocytes, making them potential candidates for treating bone fractures, cartilage defects, and conditions like osteoarthritis.

3. **Cardiac Repair**: In studies focused on heart regeneration, ADSCs have been investigated for their ability to differentiate into cardiomyocytes (heart muscle cells) and secrete factors that can improve heart function after injury or disease.

4. **Wound Healing and Skin Regeneration**: ADSCs promote wound healing by secreting growth factors that stimulate tissue regeneration and reduce inflammation. They are also studied for use in skin grafts and burn treatments.

5. **Vascularization**: Due to their angiogenic properties, ADSCs can promote the formation of new blood vessels, which is important in healing damaged tissues, particularly after injuries or surgeries.

Challenges and Limitations:

1. **Differentiation Control**: While ADSCs have the potential to differentiate into various cell types, controlling this differentiation in vivo (in the body) and in vitro (in the lab) remains a challenge. More research is needed to optimize protocols for directing ADSCs toward specific lineages.

2. **Immune Response**: Although ADSCs have immunomodulatory properties, the potential for immune rejection remains a concern when using cells from allogeneic (donor) sources.

3. **Tumorigenicity**: As with other stem cells, there is a risk of tumor formation, especially if the stem cells proliferate uncontrollably. Therefore, careful monitoring is necessary in clinical applications.

4. **Long-term Efficacy**: While ADSCs show promise in short-term studies, long-term outcomes and the sustainability of their regenerative effects in human patients need further investigation.

Conclusion:

ADSCs are a promising cell type for various regenerative therapies, including nerve repair, bone and cartilage regeneration, and wound healing. Their ability to differentiate into multiple cell types, promote tissue repair through secreted factors, and their relative ease of harvesting make them an attractive option for clinical applications. However, ongoing research is needed to address challenges related to differentiation control, long-term efficacy, and safety in clinical settings.

A study explores the efficacy of a neural graft constructed using adipose mesenchymal stem cells (ADSC), acellular microtissues (MTs), and chitosan in the treatment of peripheral nerve defects.

Stem cell therapy with acellular MTs provided a suitable microenvironment for axonal regeneration

and compensated for the lack of repair cells in the neural ducts of male 8-week-old Sprague Dawley rats.

In vitro, acellular MTs retained the intrinsic extracellular matrix and improved the narrow microstructure of acellular nerves, thereby enhancing cell functionality. In vivo, neuroelectrophysiological studies, gait analysis, and sciatic nerve histology demonstrated the regenerative effects of active acellular MT. The Chitosan + Acellular-MT + ADSC group exhibited superior myelin sheath quality and improved neurological and motor function recovery.

Active acellular-MTs pre-cellularized with ADSC hold promise as a safe and effective clinical treatment method for peripheral nerve defects [1].

The study on the chitosan/acellular matrix-based neural graft carrying mesenchymal stem cells presents a promising approach for enhancing peripheral nerve repair. The combination of adipose-derived stem cells (ADSC) and acellular microtissues (MTs) encapsulated in chitosan scaffolds demonstrated positive outcomes in both in vitro and in vivo models, showing improved nerve regeneration, myelin sheath quality, and functional recovery. These results suggest that this innovative graft could provide a potential solution for treating peripheral nerve defects.

However, the study's impact is limited by certain weaknesses, such as the lack of detailed control groups, short-term follow-up, and insufficient mechanistic insights into the regeneration process. Further studies, including long-term evaluations, larger sample sizes, and a more thorough understanding of the cellular mechanisms, are necessary to confirm the clinical applicability and safety of this approach in humans. Despite these limitations, the study lays a promising foundation for future research in regenerative medicine and peripheral nerve repair.

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Zhang Z, Li M, Cheng G, Wang P, Zhou C, Liu Y, Duan X, Wang J, Xie F, Zhu Y, Zhang J. A chitosan/acellular matrix-based neural graft carrying mesenchymal stem cells to promote peripheral nerve repair. Stem Cell Res Ther. 2024 Dec 31;15(1):503. doi: 10.1186/s13287-024-04093-5. PMID: 39736729.