Adult adipose mesenchymal stem cell implantation for one step knee chondral defects repair

Fabio Valerio Sciarretta
Claudio Ascani

Clinica Nostra Signora della Mercede Rome - Italy
Regenerative medicine, and particularly stem cell therapy, has rapidly evolved during the last years and has become one of the main "one step surgery" choices.

Mesenchymal stem cells have been proposed as a potential source of cells for cell-based cartilage repair due to their ability to self-renew and undergo multi-lineage differentiation and their use has the advantage to avoid primary surgery for cartilage biopsy and subsequent chondrocytes cultivation.

Adult mesenchymal stem cells (MSCs) have been mainly isolated from bone marrow, but, recently, adult adipose tissue-derived stromal cells (ADSCs) have received greater interest to reconstruct damaged cartilaginous tissue, because they are easily harvested in large numbers compared to other stem cells sources, since there is no other human tissue expendable as adipose tissue, making it relatively easy to isolate adequate numbers of ASCs for possible human therapies.
In 2006 several Authors demonstrated that the number of SVF cells that can be isolated from subcutaneous liposuction aspirates is approximately $0.5 \times 10^6$ to $2 \times 10^6$ cells per gram of adipose tissue, whereby the percentages of stem cells range from 1 to 10%, most likely depending on the donor and tissue harvesting site. Therefore, approximately $0.5 \times 10^4$ to $2 \times 10^5$ stem cells can be isolated per gram of adipose tissue, varying among patients.

Stem and progenitor cells in the uncultured stroma-vascular fraction (SVF) from adipose tissue usually amount to up to 3% of the whole cells, and this is 2,500-fold more than the frequency of stem cells in bone marrow.

In 2006 several Authors demonstrated that the number of SVF cells that can be isolated from subcutaneous liposuction aspirates is approximately $0.5 \times 10^6$ cells per gram of adipose tissue, whereby the percentages of stem cells range from 1 to 10%, most likely depending on the donor and tissue harvesting site. Therefore, approximately $0.5 \times 10^4$ to $2 \times 10^5$ stem cells can be isolated per gram of adipose tissue, varying among patients.

Different papers, and especially the very recent by Strioga and coworkers, have cleared that, in clinical applications, ADSCs are as effective as BM-MSCs and that can be differentiated into chondrocyte-like cells and can therefore be useful to treat cartilage defects or cartilage degenerative disease.
Once the chondral defect has been arthroscopically identified and debrided, in local anesthesia, we extract, by a simple, minimally invasive method of liposuction aspirate, with a specifically created adipose tissue biopsy needle, the marrow tissue from adult adipose tissue of the abdomen. The vacuum syringe with the few ml of liposuction tissue is, bedside in the OR room, connected to the collection bag of pre-treatment, where the infuse content is mechanically filtered.
The stromal-vascular fraction of cells is separated from the mature lipid-laden adipocytes and the water cell-free component by centrifugation according to a specific centrifugation protocol for 10 minutes. This fraction, which represents a heterogeneous population of cells, contains the ADSCs in a large number, with yields of approximately 250,000 cells per gram of tissue. Then, adding fibrin glue to the concentrated ADSCs obtained by centrifugation, we obtain a sticky clot that is ready to be easily implanted in the osteochondral prepared defect, with or without the use of a collagen membrane scaffold.
Our ADSCs experience

- First 5 patients with grade 3 & 4 knee chondral defects treated by ADSCc implantation with or without the use of a collagen membrane scaffold
- Age (28-48 yy)
- Arthroscopically assisted procedure
- Clinical: IKDC: initial improvement @ 6 months
- No adverse reaction
- Immediate ROM and muscle strengthening
..today is..

clinically valid

simple

quick

low cost

Specifically:

it has the advantage of not requiring harvesting of cells from the joint surface, and its associated donor site morbidity. The adipose tissue lipoaspirate procedure is a well known technique, simple and low-risk by the use of the specific blunt-tipped biopsy needle. In this technique, the direct culture in the OR of the adipose mechanically separated layer of cells, without the need to perform collagenase lysis, makes it a quick procedure, easy and safe to perform in the OR, and perfectly adapting to the timing requested for a single step chondral defect repair procedure.
..tomorrow may be..

- technically implementable
- growth factors
- new scaffolds

in order to regenerate hyaline cartilage tissue and inhibit OA progression

- longer clinical, MRI and histological follow-ups
References


