Biological Stability of Autologous Adipose Tissue Transplatation for Treatment of Hip Chondral Lesions

PURP0SE

The purpose of this study was to evaluate the biochemical factors involved in the chondrogenetic process related to autologous adipose tissue transplantation, for the treatment of chondral lesions in the hip. We analysed the regenerative capacities of the transplant and its effects on a stable biological activity. Our intent was to demonstrate that the autologous adipose tissue transplantation has an intrinsic biological stability and that a mechanical stability of the transplant is not needed to guarantee an effective treatment.

MATERIALS and METHODS

Autologous adipose tissue transplant is obtained from a standard lipoaspirate, processed by clearing both the oily mass and blood residuals and isolating stromal vascular fractions (lipogems®). A mechanical test was performed to compare the compressive strength and the Young elastic modulus of adipose tissue and the transplant. We evaluated the percentage of mesenchimal stem cells present in the transplant, the cellular capacity to produce collagen and GAG and the potentials to chondrogenic differentiation, under the signalling action of TGF-β and FGF-2 factors, as well as the gene expression of protein SOX-9. We also tested the cellular affinity of the transplant to healthy and damaged cartilage and its chondrogenic potentials. Finally we investigated the paracrine effect of autologous adipose tissue transplant on chondrocyte proliferation and cartilage matrix protection using MMP-3 and MMP-13 proteases expression.

RESULTS

Autologous adipose tissue transplant (lipogems®) is a gelatinous viscose tissue, very rich in bio active units called stromal vascular fractions. Mechanical tests demonstrated that this tissue has a significant increase of compressive strength and Young modulus compared to adipose tissue (Fig. 1–2).

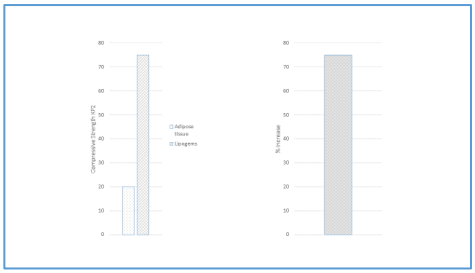

Fig. 1 compressive strength

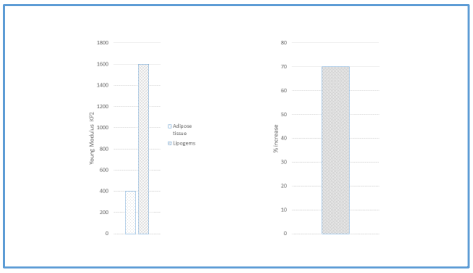

Fig. 2 Young elastic modulus

The concentration of mesenchimal stem cells in the transplant was 2%, therefore much higher compared to the one estimated from bone marrow (0.02%) or from microfractures (0.0002%). Cellular capacity to produce collagen type I/II and GAG was 93% and 90% respectively (fig. 3-4).

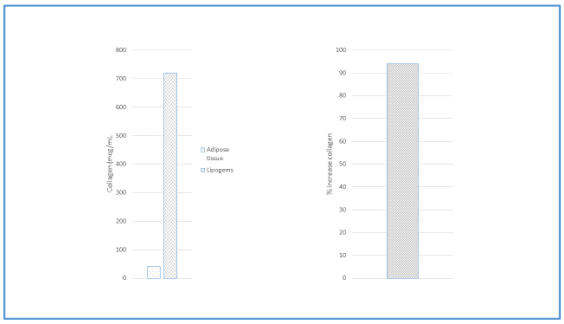

Fig. 3 collagen expression.

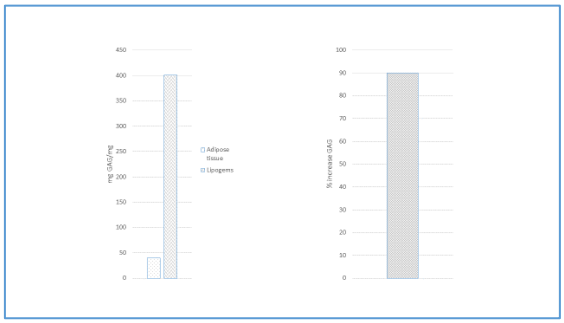

Fig. 4 GAG expression.

Chondrocytes differentiation, estimated by SOX-9 protein gene expression, was 0.0004 (2-DCT), demonstrating a significant differentiation rate of mesenchymal stem cells (fig. 5).

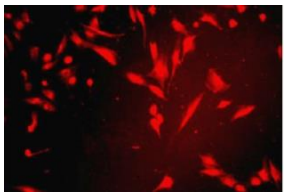

Fig. 5 Active Chondrotiytes marked with SOX-9 Ab.

Cytokines TGF-β and FGF-2 positively influence the chondrogenic differentiation. The transplant demonstrated to have a low or absent cellular affinity and chondrocyte differentiation capacity to normal cartilage (Fig. 6).

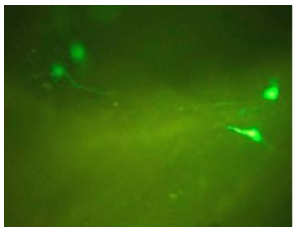

Fig. 6 Very few chondrocytes active on a normal chondral surface.

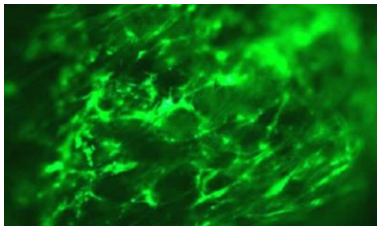

Fig. 7 Increased chondrocytes activity on a damaged chondral surface.

On the contrary cellular affinity and chondrocyte differentiation capacity were very highly expressed on chondral lesions (Fig. 7). MMP-13 proteases expression was significantly lower when associated to autologous adipose tissue transplant, demonstrating a significant paracrine effect.

DISCUSSION

Chondral defects in the hip are very frequent and actually represent a field of major concern for treatment, mainly because biological processes are involved. Biological stability is the expression of all factors involved in a biochemical process resulting in a stable biological activity. In orthopaedics biological stability is opposed to primary stability, which comes from mechanics. Stromal vascular fraction units contained in autologous adipose tissue transplant act as a scaffold for mesenchymal stem cells, enhancing potentials for chondrogenic differentiation. This process appears to be independent from a stable implant and much more correlate to biochemical signals.

CONCLUSIONS

Autologous adipose tissue transplant demonstrated to have a major biological activity and stability to guarantee a regenerative chondrogenetic process in the treatment of hip chondral lesions.

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