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CASE REPORT

Intra-Articular Injection of a Vital Micrograft Combined With a Metabolic Solution for Knee Osteoarthritis: A Case Report on Novel Two-Phase Regenerative Treatment

Fabiano Svolacchia,[1] Lorenzo Svolacchia[2]

Abstract

Knee osteoarthritis is a prevalent degenerative joint disorder characterised by the gradual deterioration of the protective cartilage in the knee with limiting treatment options. A 55-year-old male with symptomatic knee osteoarthritis underwent a novel two-phase regenerative treatment combining micro-fragmented adipose tissue injection with metabolic solution infiltration. The patient presented with medial and anterior knee pain (visual analogue scale - VAS 4.5, knee injury and osteoarthritis outcome score - KOOS 64 %). Treatment involved intra-articular injection of 20-40-micron microfiltered adipose tissue followed by a solution containing non-cross-linked hyaluronic acid, branched amino acids and sodium bicarbonate to activate membrane glycoproteins and drive adipose-derived stem cells (ADSCa) to exosome budding. At six months, dramatic improvement was observed with VAS decreasing to 0.5 and KOOS increasing to 95 %. No adverse reactions occurred. This minimally invasive technique represents a promising approach for early-stage knee osteoarthritis treatment.

Key words: Osteoarthritis; Stem cells, adipose-derived; Regenerative medicine; Knee joint; Adipose tissue, microfiltered; Exosomes.

1. Department of Sense Organs, University of Rome "La Sapienza", Rome, Italy.
2. Department of General Surgery, University of Rome "La Sapienza", Rome, Italy.

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Corresponding author:
FABIANO SVOLACCHIA
E: fabiano.svolacchia@gmail.com
T: +393384380491

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Introduction

Knee osteoarthritis is a prevalent degenerative joint disorder characterised by the gradual deterioration of the protective cartilage in the knee. This deterioration leads to pain, stiffness, swelling and decreased mobility, often resulting in bone-on-bone friction as the condition advances. It is a form of wear-and-tear arthritis that primarily affects older adults, with risk factors such as age, weight, previous injuries and genetics. Management options include exercise, pain relief (such as non-steroidal anti-inflammatory drugs (NSAIDs) or steroid injections), weight loss and possibly surgery (knee replacement) for severe cases, as there is currently no cure. Adipose-derived stem cells (ADSCs) are a promising area in regenerative medicine for tissue repair and disease treatment due to their self-renewal and differentiation abilities.[1-4]

Case history

A 55-year-old male presented with symptomatic medial and anterior knee pain associated with

sedentary lifestyle and elevated body mass index (BMI). Clinical examination revealed visual analogue scale (VAS) pain score of 4.5, knee injury and osteoarthritis outcome score (KOOS) functional score of 64 %, peripatellar tenderness and positive J sign. Radiological assessment showed medial femoral condyle chondropathy grade II with bone marrow oedema and patellofemoral grade II osteoarthritis.

Therapeutic intervention

The patient underwent our novel "ExoSowing from UltraGraft" technique - a two-phase regenerative treatment approach.

Phase 1: Adipose tissue was harvested from the peritrochanteric region using a 2.5 mm multihole cannula under local anaesthesia. Approximately 10 mL of lipoaspirate was processed through mechanical fragmentation and microfiltration using a 20–40-micron filter to obtain 2.5 mL of microfiltrate containing tissue progenitors while eliminating inflammatory cellular debris.[1] The microfiltered tissue underwent controlled hypoxic conditioning for 240 ± 60 s to enhance exosome release before intra-articular injection via 21G needle.[2]

Phase 2: Fifteen minutes later, a metabolic and protective solution containing non-cross-linked hyaluronic acid, branched amino acids and sodium bicarbonate was infiltrated intra-articularly. This solution creates optimal pH conditions and provides CD44, CD73, CD90 and CD105 binding sites for stem cell activation while supplying metabolic substrates for cellular function and to enhance exosome release.

Clinical outcomes

Follow-up assessments at 1, 3 and 6 months demonstrated progressive improvement:

- **1 month:** VAS 3.0, KOOS 77 %;
- **3 months:** VAS 1.5, KOOS 92 %;
- **6 months:** VAS 0.5, KOOS 95 %.

No adverse reactions were observed throughout the follow-up period (Figure 1).

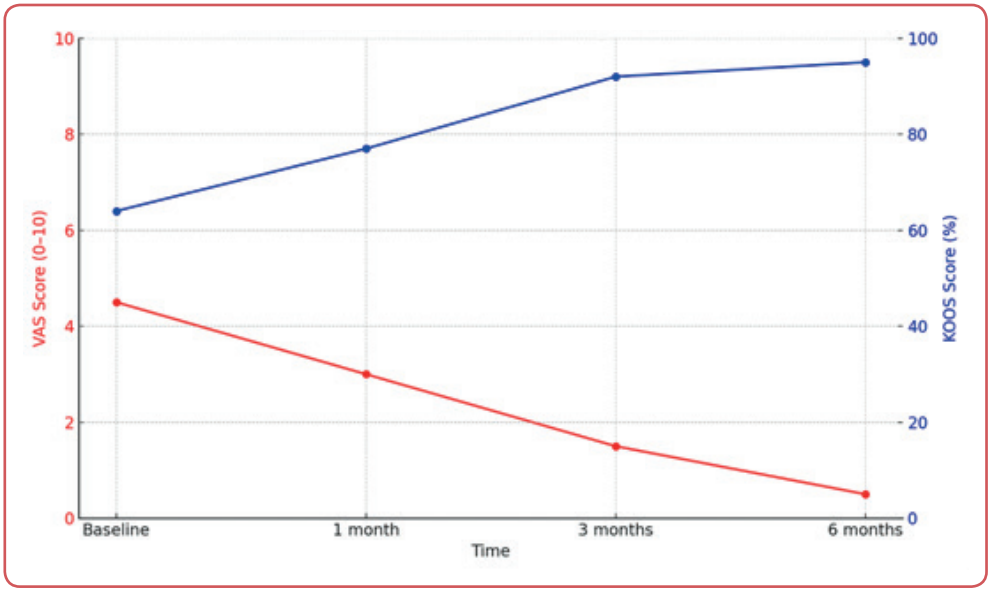

Figure 1: Progression of clinical outcomes following ExoSowing from the UltraGraft technique

Red line (left axis): the visual analog scale (VAS) scores, which indicates the perception of pain, decreased over time from 4.5 to 0.5. Blue line (right axis): the knee injury and osteoarthritis outcome score (KOOS), which indicates functional recovery, increased from 64 % to 95 %. Variation (Baseline → 6 months): VAS: -4.0 (-88.9 %); KOOS: +31 (+48.4 %);

Discussion

This case demonstrates the potential efficacy of combining microfiltered adipose tissue 20-40-microns with metabolic solution for knee osteoarthritis treatment. The observed improvements (VAS reduction of 4.0 points, KOOS improvement of 31 points) substantially exceed

established minimal clinically important differences for both measures.[5] The minimal clinically important difference (MCID) for VAS pain scores is typically 1.5-2.0 points and that for the KOOS is 8-10 points.[5] Observed changes represent effect sizes of approximately 2.0-2.7 for the VAS score and 3.1-3.9 for the KOOS score compared to typical standard deviations reported in similar populations.

The therapeutic mechanism of treatment involves multiple synergistic pathways. Microfiltration to 20-40 microns selectively preserves tissue progenitors and mesenchymal stem cells while eliminating fibrous debris that would trigger inflammatory responses via Toll-like receptor 4 activation.[1] This approach is consistent with the joint statement from the International Federation for Adipose Therapeutics and Science (IFATS) and the International Society for Cellular Therapy (ISCT) regarding stromal cells from adipose tissue.[6]

Controlled hypoxic preconditioning activates hypoxia-inducible factor-1α pathways, increasing survival gene expression and stimulating exosome release containing anti-inflammatory microRNAs and growth factors. The hypoxic environment also stimulates the release of specific exosomal cargo that promotes tissue regeneration.[2]

The metabolic solution optimises the cellular microenvironment through CD44-hyaluronic acid binding, which activates stem cell survival pathways, while branched amino acids provide metabolic substrates for cellular biosynthetic processes with CD73, CD90 and CD105. Sodium bicarbonate maintains optimal pH, counteracting the acidic inflammatory environment typical in osteoarthritic joints.[4]

Previous studies have demonstrated the potential of adipose-derived stem cell therapies for treating osteoarthritis. However, most approaches involve enzymatic digestion and cell culture expansion, which are subject to regulatory restrictions. This minimal manipulation approach offers several advantages over enzymatic cell processing methods: reduced regulatory burden, preservation of native cellular architecture and maintenance of paracrine signalling mechanisms.[1,3] The technique addresses the known challenge of poor stem cell survival in the hostile joint environment by creating protective cellular niches.
The two-phase approach addresses multiple aspects of joint degeneration simultaneously. Microfiltrated adipose tissue provides cellular therapeutic components, while the metabolic solution creates an optimal microenvironment for cell survival and function. This synergistic effect likely contributed to the sustained clinical improvement observed over the six-month follow-up period.

The technique involves accurate tissue selection that preserves tissue progenitors without loss of original structure and biological function.[1,3] The effect induced by temporary hypoxia permits exosome release from adipose-derived stem cells contained in the microfiltrate.[2] The metabolic solution allows positive interactions with surface markers expressed on tissue progenitors and protects cells by mimicking niches that protect stem cells in a highly hostile environment such as the knee joint.[1]

Study limitations include single-case presentation, absence of control group, relatively short follow-up period and lack of imaging studies to assess structural changes. Patient age (55 years) represents an optimal range for adipose-derived stem cell therapy and its exosomes, as cellular regenerative capacity decreases significantly after age 60. The technique was applied to early-stage osteoarthritis (Grade II chondropathy); patients with more advanced cartilage loss may demonstrate different response patterns.

Conclusion

The "ExoSowing from UltraGraft" technique combining microfiltered adipose tissue 20-40 microns with metabolic solution infiltration yielded excellent clinical outcomes for treating knee osteoarthritis. This minimally invasive approach offers a promising treatment option for early-stage disease with significant symptom improvement and excellent safety profile. Further controlled studies with larger patient cohorts are warranted to validate these preliminary findings.

Ethics

Our institution does not require ethics approval for reporting individual cases or case series. A written informed consent for anonymised patient information to be published in this article was obtained from the patient.

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None.

Conflicts of interest

The authors declare that there is no conflict of interest.

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Data access

The data that support the findings of this study are available from the corresponding author upon reasonable individual request.

Author ORCID numbers

Fabiano Svolacchia (FS):
0000-0002-0522-7584
Lorenzo Svolacchia (LS):
0000-0002-7358-2318

Author contributions

Conceptualisation: FS, LS
Methodology: FS, LS
Software: LS
Validation: LS
Formal analysis: FS, LS
Investigation: FS, LS
Data curation: FS, LS
Writing - original draft: FS
Writing - review and editing: FS, LS
Supervision: GP, DJ

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