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Case Report

Subchondral Cyst Causing ACI Graft Failure Treated with Tissue Autologous Engineered Chondral Plug

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Abstract

We present the case of an adolescent, with increasing right knee pain, three years following Autologous Chondrocyte Implantation (ACI). Magnetic Resonance Imaging (MRI) demonstrated a large subchondral cyst formation under the implanted graft. The patient underwent a second ACI implantation. The new implant design consisted of a round shaped plug with a conic base, a shape suitable for filling in the ablated subchondral cyst, as well as for restoring the previously damaged cartilage surface.

Keywords: Autologous; chondrocyte; implant; subchondral cyst.

Introduction

Since the advent of cell-based therapy and various Autologous Chondrocyte Implantation (ACI) technologies, a growing number of patients face the need for further treatment in the case of graft failure. Due to increased experience and extended follow-up times, new clinical challenges are being met with regard to ACI. Subchondral cyst formation is a recognized progressive complication threatening graft integrity [1]. Second line treatment of failed ACI in presence of subchondral cyst is less established and varies from osteochondral engineered plugs, allografts, retrograde drilling, or re-do ACI with bone graft [2]. Literature survey indicates this report to be the first to present a failed ACI surgery revised with a similar technology but with a different implant that seems to properly address the subchondral cyst [1].

Case report

A 14-year-old adolescent presented with right knee pain and effusion, twelve months following an indirect injury during a martial arts tournament. Arthroscopy revealed a full thickness chondral flap on the Lateral Femoral Condyle (LFC). Trimming of the lesion and microfracture was performed. Following a structured rehabilitation, he resumed normal aged matched activities. Four years later, he began complaining of painful catching symptoms in the operated knee.

Plain x-ray revealed a large chondral body in the suprapatellar pouch. A second arthroscopy demonstrated a thin regenerated fibrocartilage layer at the lesion site on the LFC. A large chondral body was removed from the joint (Figure 1). Cartilage sample was harvested from the supero-medial trochlea for cell culture. Via lateral mini-arthrotomy approach, a 17X17 mm full thickness lesion on the LFC was trimmed and prepared for grafting with a third generation ACI product, based on chondrocytes culture in an open-pore fibrinogen scaffold with FGF-v, Biocart II (Prochon, Nes Ziona, Israel).

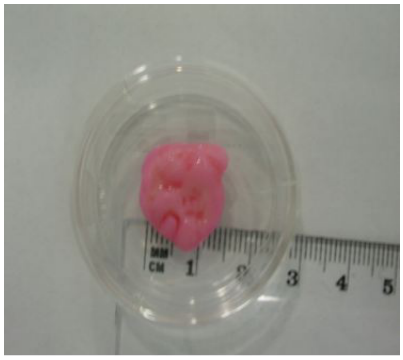

Figure: 1 Loose chondral body removed from the knee

Three years later, after leading a physically active life, the pain symptoms recurred. An MRI revealed a large subchondral cystic formation underneath the previously grafted area (Figure 2).

Figure: 2 Subchondral cyst underlying the graft (MRI water sensitive sequence)

Revision surgery was undertaken with a third generation ACI product, where chondrocytes cultured on a 3-D hydrogel scaffold consist of chitosan and agarose Cartipatch® (TBF, Mions, France) [3]. The design (Figure 3), of a round plug, with a conic base (bone side) and flat top (articular side), provided in various diameters was particularly suitable for treatment of the patient's pathology. Cartipatch was provided as part of a Phase III clinical trial being conducted at the time. Since it was considered a suitable option for the patient, it was approved as a "compassionate" procedure. The surgical instrumentation contained drills matching the graft diameter and shape for the preparation of the osteochondral site for grafting. Thus, ablation of the subchondral cyst was achieved, as well as a fresh bony bed to conform to the new graft shape and construct.

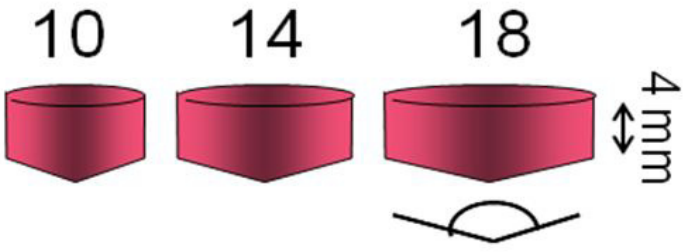

Figure: 3 Cartipatch graft structure and shape

Twelve months following surgery the patient reported marked pain relief. He returned to a physically active profession and recreational sports. Follow-up MRI demonstrated disappearance of the subchondral cyst, with a fully integrated and congruent cartilage segment (Figure 4). At 48 months, the patient remains active and pain free.

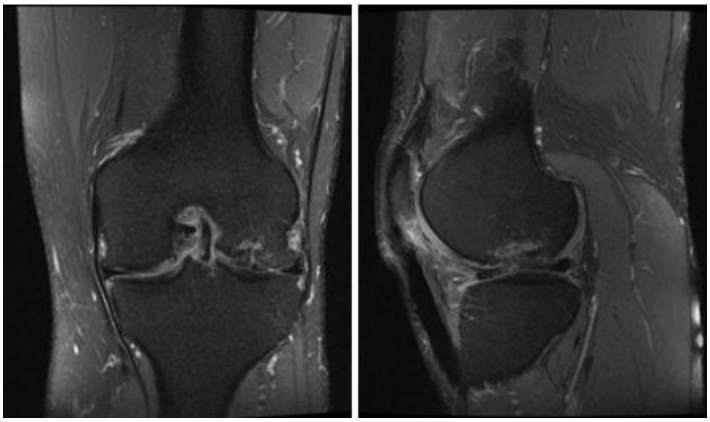

Figure: 4 The revised cartilage segment (MRI water sensitive sequence) at 24 month

Discussion

Undoubtedly ACI procedures have matured and are gaining recognition as an effective treatment for large chondral and osteochondral defects [1,4]. This hard won recognition is due to the intrinsic biological characteristics of the various autologous chondrocyte therapy products available, as well as the drawbacks of the presently established first-line of treatment, microfracture [5,6].

The subchondral bone plate and its importance have been progressively studied since the initiation of ACI. Currently the "cartilage-subchondral plate-bone unit" is viewed as an integrated entity [7].

A few complications related to the subchondral bone in cartilage surgery have been described, including subchondral cyst formation [1,8]. The presence of an evolving subchondral cyst under an ACI graft in a weight bearing zone is a potential threat to graft biomechanical stability, and could lead to delamination and graft failure [9].

Internal osteophytes formation, described as bone irregularity due to local hypertrophy, were demonstrated over time after first generation ACI performed with periosteal flaps overlaying the cell suspension [1,8,10].

Previous surgeries, such as microfracture, have been described as having a deleterious effect on the subchondral plate, with negative influence on clinical results and graft durability. Subsequent radiology has also shown the reduced tissue quality, low fill, and irregular appearance of newly formed implanted tissue [11].

Finally, cystic formation in the subchondral plate as part of the natural history of trauma, surgery with Open Reduction and Internal Fixation (ORIF) of detached large cartilage fragments, or pathologies treated with ACI (e.g. Osteochondritis Disscans) may develop to a sizeable volume, to the extent of threatening the structural and mechanical stability of the articular surface [8].

Failed ACI with deep subchondral defects has been approached with the "Sandwich" procedure where bone graft of the defect preceded cartilage resurfacing [2]. Although the reported clinical outcome of the treatment of deep osteochondral and revision ACI are favorable, caution needs to be exercised, particularly with regard to individualized treatment, as clinical trials are still underway.

A single case series addressing revision surgery after third generation ACI was found in the literature [12], none of the patients were addressed with second ACI procedure.

The need for solutions to functional deterioration in young patients who have undergone a "first round" of various cartilage regenerating procedures can be expected to be encountered in growing numbers. Hence, we regard this case report as a contribution to the existing literature regarding ACI and a treatment option for subchondral cyst.

Acknowledgements

The authors declare that they have no conflict of interest. Figure 3 is provided with the permission of the Tissue Bank France (TBF), via Dr. L. Barnouin.

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