

Knee Preservation Techniques for Severe Synovial Osteochondromatosis in End-Stage Osteoarthritic Knee Using High Tibia Osteotomies, Cartilage Restoration Procedure, and Biologic: A Case Report in Bilateral Knees

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Abstract

Synovial osteochondromatosis can occur idiopathic or secondary to osteoarthritis. While joint replacement surgery has shown promising results for end-stage osteoarthritis, it isn't always the answer for certain individual. In young athletic individual, the treatment should be patient specific, with consideration for return to sports activities. We present a 48-year-old ex-national professional football player with significant osteoarthritis and severe synovial osteochondromatosis. After discussion with the patient, we decide that knee preservation is suitable for him. Surgical treatments that are considered the best option are High Tibial Osteotomies, extraction of the loose bodies, partial synovectomy, and microfracture. Those procedures were performed in 8 months interval for each knee. The patient received intra-articular injection of cultured Mesenchymal Stem Cells (MSCs) with hyaluronic acid for 4 weeks after surgery. In a 34-month follow-up for right knee and 26-month follow-up for left knee, the patient regained significantly higher Knee injury and Osteoarthritis Outcome Score (KOOS) compare to before surgery (94 vs. 47). Radiologic examination also reveals the improvement of both knees joint space.

Keywords: Osteoarthritis, sport, knee preservation, high tibial osteotomies, mesenchymal stem cel

Level of Evidence: IV



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Introduction

The management of End-Stage Osteoarthritis in young, athletic patients is extremely challenging.¹ surgical treatments such as arthroscopic debridement or knee replacement have limitation in long-term efficacy or appropriateness for this type of patient.^{1,2} Joint preservation surgery is most difficult in patients with concomitant knee pathologies, including cartilage defects, meniscal deficiency, malalignment, and/or intraarticular pathology such as synovial chondromatosis. Synovial chondromatosis can occur as either a primary or secondary form. Primary synovial chondromatosis, which is more rare, occurs spontaneously and does not appear to relate to any pre-existing conditions.

Secondary synovial chondromatosis is the more common form and often occurs when there is pre-existent osteoarthritis, rheumatoid arthritis, osteonecrosis, osteochondritis dissecans, neuropathic osteoarthropathy (which often occurs in diabetic individuals), tuberculosis, or osteochondral fractures in the affected individual.³

Diseases and injuries can cause joint deformity including osteoarthritis. Once the knee is mal-aligned because of the deformity, abnormal force is applied to specific areas of that knee. The abnormal force applied to the knee can cause increased pain and other symptoms. Realignment osteotomy is effective in offloading the affected arthritic compartment by performing a valgus or varus correction for a medial or lateral disease, respectively.² The use of biologic therapy as an alternative to or to augment more conventional surgical management has increase in popularity in the past decade, and indications for biologic therapy continue to evolve.¹ Mesenchymal Stem Cells (MSCs) are considered to be the most promising cells for cartilage regeneration by cell transplantation, and they have been applied clinically. MSCs that differentiate into chondrocytes are induced by molecules, cytokines (which are mainly growth factors), and the microenvironment in the cultured cells.⁴ Microfracture used to treat articular cartilage injuries can facilitate access to stem cells in the bone marrow and stimulate cartilage regeneration. Following microfracture in rabbit knee cartilage defects,

application of hyaluronic acid gel resulted in regeneration of a thicker, more hyaline-like cartilage.⁵

Case Presentation

We present a 48-year-old ex-national professional football player with significant osteoarthritis and severe synovial osteochondromatosis. When discuss with the option for knee replacement, he was more interested in a joint preservation option.

He had varus deformity on right knee, which showed excessive stress on the medial part of the knee. The joint space on the lateral side of left knee is narrowed from cartilage degeneration. The plan was to correct the right knee with medial opening wedge osteotomy and insertion of a titanium plate. This will unload the damaged medial compartment. The plan for left knee is closing wedge osteotomy to unload the damaged lateral compartment. First surgery was performed on right knee on July 2017. The authors performed the surgeries. Patient underwent open arthrotomy through midline incision and medial parapatellar approach. We removed all foreign bodies (Figure 1) and continued with partial synovectomy. Microfracture was performed for their cartilage injury. The procedure involved accurate debridement of all unstable and damaged cartilage in the lesion. All loose or marginally attached cartilage were also debrided from the surrounding rim of the defect to form a stable perpendicular edge of healthy cartilage. An arthroscopic awl was then used to make multiple holes in the defect, 3 mm to 4 mm apart. During the same procedure, the patient had their MSCs harvested from the posterior iliac crest bone marrow. Also, 80 mL of venous blood sample from the upper limb of the patients were drawn in the same sitting. Cell culture and expansion was performed in our Government approved tissue-engineering laboratory.

Opening wedge osteotomy with autograft from iliac wing is performed to correct varus deformity, this procedure could correct tibiofemoral angle from varus 10.82° to valgus 1.64° (Figure 2). Approximately 3 weeks after bone marrow aspiration, there are approximately 10 million passage 1 cells ready for injection. The cells were transported in 2 mL of patient's own serum. The patients then received intra-articular

injections containing the MSCs followed by 3 mL of Hyaluronic Acid (Durolane®) in the outpatient clinic.

Those procedures were performed in 8 months interval for left knee (March 2018). While the right knee had opening wedge osteotomy, the left knee had closing wedge osteotomy to reduce to overload in lateral compartment of the knee, this procedure reduce femorotibial angle from 8.37° to 3.69° (Figure 2). The left knee received MSCs and Hyaluronic Acid supplementation as well.

In a 34-month follow-up for right knee it showed that right leg is well aligned, the proximal tibia osteotomy is well healed and the medial joint space and pain are improved. At 26 months follow up, the left leg is well aligned, the proximal tibia osteotomy is well healed and the lateral joint space and pain are improved. The patient regained significantly higher Knee injury and Osteoarthritis Outcome Score (KOOS) compare to before surgery (94 vs. 47). Now he can even back playing in “the legend team” game although sport levels decreased.



Figure 1. Osteochondromatosis fragments in right and left knee

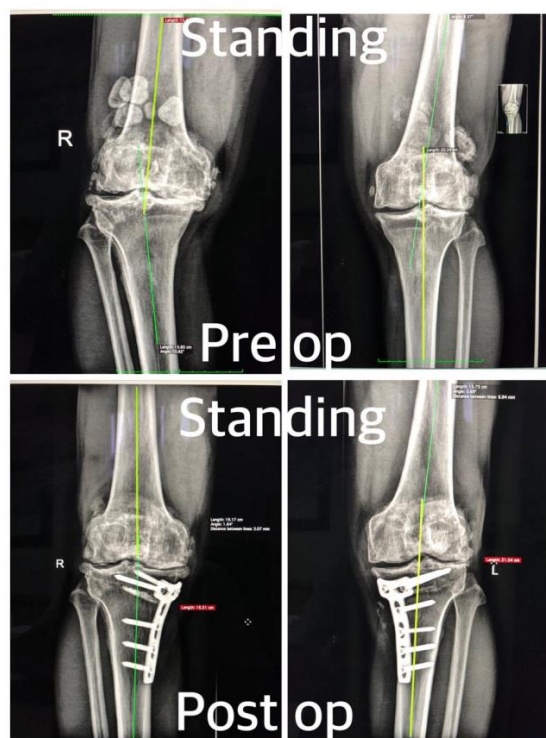


Figure 2. Comparison of right and left knee before and after correction

Discussion

The management of complex knee pathology in young, athletic patients are challenging. Various joint preservation strategies have been introduced in the past several decades, with biologic therapy recently being incorporated into the treatment algorithm for complex knee pathology.¹ One of the strategies is realignment osteotomy since malalignment is a common source of knee pain and may have detrimental effects on the overall health of a knee. Offloading damaged compartments as an adjuvant procedure to joint restoration, or as an adjuvant procedure in instability cases, is also a good indication for knee osteotomy. The procedure provides both offloading components as well as a more favourable mechanical environment in the presence of ligament laxity. In recent studies conduct by Witjes et al², the return to sport rate following the realignment osteotomies was 95% of whom 53% were to high-impact sports. A key advantage of High Tibial Osteotomy may allow unlimited activity following surgery, including

running, jumping, cutting and pivoting.² The result of our patient seem to support this concept. The microfracture technique often is considered the golden standard therapy for the treatment of cartilage defects. The first results and the technique were published in 1994. This technique is based on thought that by perforating subchondral bone can facilitate access to stem cells in the bone marrow and stimulate cartilage regeneration.⁵

Recently, the use of biologics for the management of articular cartilage lesions has increased considerably. Although scientific and clinical evidence on biologic therapy is evolving, biologics may help prevent articular cartilage lesion progression and may play a role in the nonsurgical and surgical management of osteoarthritis and focal chondral lesions. The biologic agents most frequently used for articular cartilage and meniscal management include platelet-rich plasma (PRP), mesenchymal stem cells (MSCs), and biologic scaffolds. Interpretation of the literature on the use of PRP, stem cells, and scaffolds to augment knee joint preservation surgery is a challenge because of the paucity of studies with midterm to long-term follow-up and the heterogeneity of the agents used. Even among studies that analyzed the same agent, such as PRP, preparations may differ, which makes the interpretation of results a challenge.¹

The use of mesenchymal stem cells as an alternative to biologic scaffolds/Autologous chondrocytes Implantation (ACI) for cartilage repair in humans has gradually gained some momentum in recent years. In a study conduct by Lee et al⁶, they compared the clinical outcomes of patients treated with first generation ACI to patients treated with bone marrow-derived MSCs. The latter have been shown to have a better proliferation rate than chondrocytes and have the capacity to differentiate to different tissues, including both bone and cartilage, under the right conditions. The results showed that patients treated by ACI and MSCs had a comparable improvement in quality of life, health, and return to sporting activities. Older patients (above 45 years) treated with MSCs also had better results compared to those treated by ACI.⁶ The other advantages of using MSCs is requiring only a single operation, while in ACI technique requiring 2 separate surgical procedures, also difficulty in

obtaining an adequate number of chondrocytes, a slow rate of chondrocyte proliferation and donor site morbidity.^{1,6}

Hyaluronic acid supplementation has both chondroprotective and chondro-inductive properties making it a suitable medium for stem cell delivery into the joint. Hyaluronan-based polymers have been shown to enhance the natural healing process of osteochondral defects in animal.^{5,7} Follow up time is 34 months for right knee and 26 months for left knee, and this is enough time for the standard 2-year follow-up for clinical study. The limitation of this case is the less optimal femorotibial correction for right knee, this because we afraid to cause any fracture if opening the wedge more than we had done. Another limitation in this study is the fact that any improvement in patients' outcome can be due to bone marrow-derived MSCs or MSCs from the subchondral bone following microfracture and also realignment osteotomies can also contribute to pain relieve.



Figure 3. Patient is able to return to sport activity

Conclusions

Knee preservation for this patient can be achieved successfully by using High Tibial Osteotomy, microfracture supplemented with Bone Marrow-Derived MSCs and Hyaluronic Acid. Patient is able to return to sport although the sport level decreased.

Conflict of Interest

The authors affirm no conflict of interest in this study

Acknowledgement

None.

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