Initial results of arthroscopic surgery for osteochondral lesions of the talus using a hyaluronic acid-based scaffold with microfracture

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Abstract

Introduction: Osteochondral Lesions of the Talus (OLT) is a rare disease in Vietnam, often overlooked in medical facilities. There are many methods of treatment, including ankle arthroscopy.

Patients and Methods: The first six patients with OLT underwent arthroscopic hyaluronic acid-based scaffold implantation with microfracture surgery in Viet Duc University Hospital in Vietnam. Three patients have been followed in 6 months using the AOFAS score and MRI.

Results: 5/6 patients were men aged between 30 and 40 years old and they play sports regularly. All the patients have passed the other hospital for pain in the ankle with no exact diagnosis. Examination for other symptoms, such as abnormal gait, ankle range of motion, ankle stability, or axial ankle deformity, were all negative. Six months after surgery, the AOFAS score in 3 patients improved from 57 and 61 to 91 and 100 points. MRI evaluation six months after surgery showed almost complete coverage of the artificial cartilage on the lesion surface.

Conclusion and recommendation: Arthroscopy using hyaluronic acid-based scaffold implantation with microfracture to treat the OLT initially brought positive results, helping patients improve pain symptoms and return to daily life. However, in the future, more studies with longer follow-up times are needed to evaluate the results of this method.

Keywords: arthroscopy, chondral lesions of the talus, hyaluronic acid-based scaffold, mesenchymal stem cells, microfracture.

Introduction

Osteochondral Lesions of the Talus (OLT) are focal injuries to the talar dome with variable involvement of the subchondral bone and cartilage which may be caused by a traumatic event or repetitive microtrauma.

Diagnosis can be made with plain ankle radiographs. MRI studies are helpful in determining the size of the lesion, the extent of bony edema, and identify unstable lesions.

Treatment can be nonoperative or operative depending on patient age, patient activity demands, lesion size, and stability of lesion. For the operative treatment, several methods have been used to stimulate cartilage growth, such as drilling stimulation, creating micro-lesions, autologous chondrocyte transplantation, autograft, and allograft (allograft in bone marrow) or using the artificial materials...

At the Department of Upper limb Surgery and Sports Medicine, Viet Duc University Hospital (VDUH), we did the arthroscopy to treat the OLT using a hyaluronic acid-based scaffold with microfracture for the first time in Vietnam in September 2021. After that, five cases were performed. Currently, three cases have been examined and re-evaluated after six months. This report aims to evaluate the initial results of this technique.

Materials and methods

Research subjects: Six patients underwent arthroscopic hyaluronic acid-based scaffold implantation with microfracture surgery at the Department of Upper limb Surgery and Sports Medicine, VDUH, from September 2021, in which three patients followed up after surgery for at least six months.

Variables:

- Clinical features: Pain, limited joint mobility, loss of ability to play sports, ankle instability

- Paraclinical features: routine X-ray film, magnetic resonance film.

- Evaluate results according to the VAS scale and AOFAS before and after surgery MRI results six months after surgery.

Methods: Prospective research and longitudinal follow-up.

Protocol:

Anesthesia: spinal anesthesia.

Patient position: supine.

Surgical instruments:

Equipment: Arthroscopy system with screen, light source, 30^0 arthroscope with 2.7 mm diameter, 3.5mm shaver, 3.5mm bur. NanoFx kit (Arthrosurface®, USA) consists of a minor, curved, 15^0 beveled handle to create boreholes. The microfracture threading rod has a constant size of 1 x 9 mm.

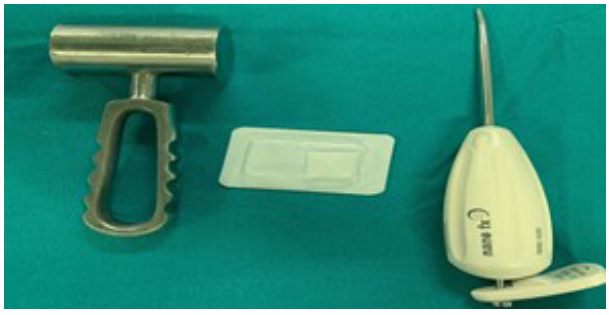

Figure 1. Instrument for creating micro-injury and artificial cartilage pad

Artificial cartilage: Hyalofast (Anika-Italia) is a 3D structural artificial cartilage product, 100% composed of Hyaluronic acid-HA of non-animal origin (fermented from cells).

Technique:

After positioning the patient tourniquet placed at the base of the leg, placing the operating leg on the leg support.

Step 1: Evaluating the OLT by arthroscopy

- Identify the anatomical landmarks and the location of the portals.

- Inject 15-20ml saline into the ankle joint.

- Enter the ankle joint through anteromedial and anterolateral ports.

- Evaluation and treatment of intraoperative injuries:

Remove osteophytes and grind the anteroinferior margin of the tibia, which causes narrowing of the anterior space.

Remove fibrous tissue, inflammatory synovia, plica, and loose bodies.

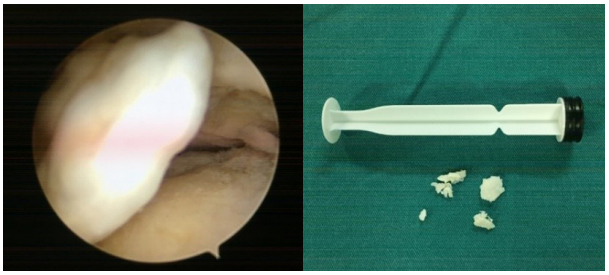

Figure 2. Loose bodies

Remove damaged cartilage from the talar surface, stimulate drilling, and create microfracture with the NanoFx tool of the cartilage defect.

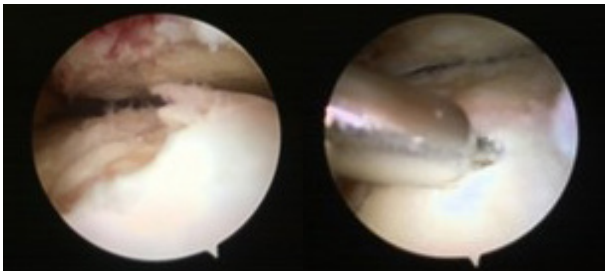

Figure 3. The talar cartilage defect and microfracture drilling

Step 2: Artificial cartilage grafting

- After preparing the base for implantation, drain all the fluid inside the joint.

- Using an artificial cartilage, the size corresponding to the injury is brought into the joint through the anteromedial entrance.

- Evenly spread the cartilage on the cartilage defect and keep it in place for 3-5 minutes with an arthroscopic grasper.

- Remove the instrument, compressed bandage, and immobilize the ankle with a cast or splint

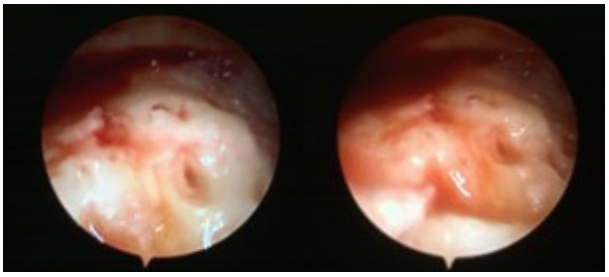

Figure 4. Pictures after grafting artificial cartilage

Postoperation:

Change the bandage and immobilize the ankle for 3-4 weeks. After that, regain ankle joint range of motion and muscle strength.

Follow-up and evaluation after surgery:

We evaluated the treatment results through AOFAS, VAS pain scale, X-ray examination immediately after surgery, and MRI after six months.

Results

Clinical features

- 5/6 patients are men aged between 30 and 40 years old. The highest is 40 years old, and the lowest is 30 years old. These patients all play sports, with almost football (4/5 patients). The female patient was 60 years old.

– The common characteristics of these patients are pain from 6 months to 1 year, and the meantime is 8 ± 3.3 months. The patients have visited many hospitals and been treated with painkillers and anti-inflammatory drugs. None of the patients received joint injections.

- The prominent clinical symptom in 6 patients was pain. Pain increases over time and increases when weight-bearing. Pain lessens or goes away when resting. All patients had to give up sports. Examination for other symptoms, such as abnormal gait, ankle range of motion, ankle stability, or axial ankle deformity, were all negative.

Radiography

- X-ray results: 1 patient had a loose body image in the anterior ankle space on the lateral view.

- MRI results: All films show a loss of talus cartilage, mainly on the anterior ankle space. 5/6 cases have lesions located in the anteromedial side of the talar dome.

Operation:

- The patient's intraoperative lesions correspond with the diagnosis on radiography. Cartilage loss is located mainly in the anteromedial side of the talar dome (5/6 patients). According to the ICRS (International Cartilage Repair Society) classification at the injured side, the lesion has wholly lost cartilage, grade IV. The injured size was between 1 cm^2 and 2 cm^2, suitable for using a 2x2 cm^2 pad.

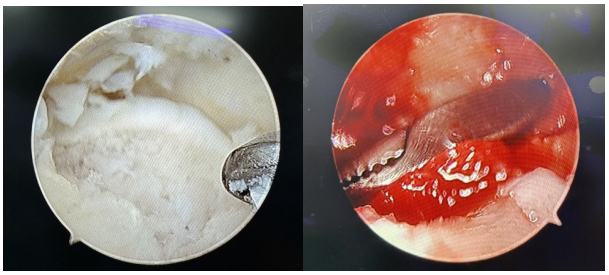

Figure 5. Injury at the anteromedial angle of the talar dome and after grafting.

- Only three patients were followed up for six months because OLT is a relatively rare disease. The remaining three patients have only had surgery from 4 to 6 weeks and are rehabilitating.

- The postoperative VAS scores of 3 patients improved significantly. All three patients had no pain (0 points) or only mild pain (1 point) compared with VAS scores from 6 to 7 points preoperatively.

- AOFAS score after six months:

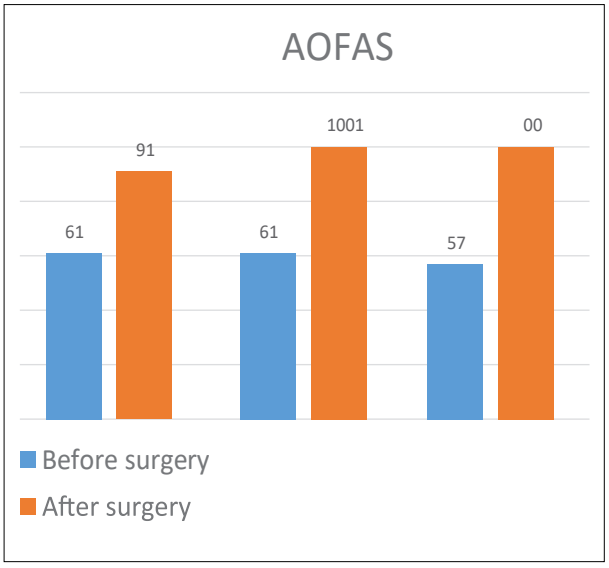

Chart 1. AOFAS score preoperation and six months postoperation.

- The results of the MRI after six months showed that articular cartilage regenerated in all three patients.

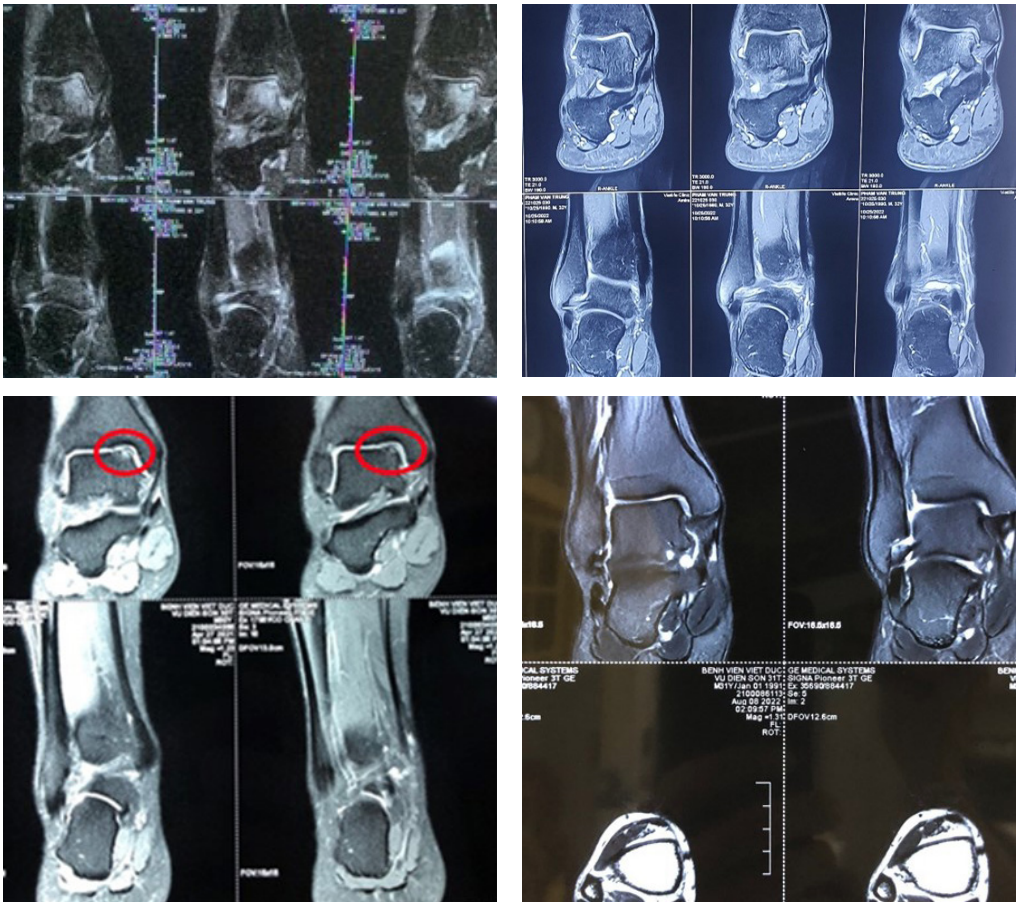

Figure 6. MRI images of 2 patients six months postoperation showed no OLT in the same slices.

Discussion

The diagnosis of acute ankle osteochondral injuries usually miss because the injury is not apparent and causes minimal or no functional limitation. It is one of the frequent causes of ankle nuisance and is commonly encountered in young sportspersons after ankle injury [1,2]. Other reasons being speculated that might lead to this problem include genetic factors, osteonecrosis, and endocrine disease, whose etiology cannot be explained [3]. Deficiencies at the cartilage region will produce deep ankle pain during load-bearing activities. A reduction in the ankle function and range of movement, catching sensation, worsening stiffness, swelling, and locking may be present. The diagnosis is usually based on the history, clinical findings, and imaging investigation by X-ray and magnetic resonance imaging (MRI) [4].

In our report, 5/6 patients between the ages of 30 and 40 were active in sports, increasing the risk of injuries to load-bearing joints, quickly leading to cartilage damage. Symptoms that affect the most for the group of diseases are also pain, which increases with activity and load. Patients often have trauma to the ankle region in the antecedents.

According to Fabian K reported in 2022, nearly 80% of patients with OLT have a history of ankle injury. Approximately 38% of patients present with ankle ligament laxity. The authors commented that acute trauma and repetitive microtrauma due to ankle instability and/or misalignment of the hindfoot appear to be the leading causes of OLT. An injury can cause cartilage damage and lead to microfractures. In ankles with choroidal damage, synovial fluid penetrates these minor cracks. Fluid loading leads to high fluid pressure, which in turn causes osteonecrosis and subsequent cyst formation. The poor vascularization of the talus leads to a higher risk of osteonecrosis and reduced healing. In particular, in the case of ankle instability and hindfoot deformity, the increased load on the cartilage can lead to degeneration or cell death by disrupting the collagen fibrillar superstructure. Other theories for the etiology of tarsal osteochondrosis include vascular, endocrine, or metabolic causes. The authors suspect that the cartilage lesion does not lead to pain but rather an osteonecrosis of the high internal subchondral bone beneath the cartilaginous defect [5]. Without a blood supply, the damaged cartilage's ability to repair or grow back on its own is almost impossible. Many methods have been used to stimulate the growth of new cartilage. In recent years, researchers worldwide have focused on new materials that can replace damaged articular cartilage, including the scaffold, with the main structure being a hyaluronic acid support frame combined with mesenchymal stem cells of bone marrow tissue.

Hyalofast is a biocompatible material that aids in the attraction of mesenchymal stem cells to repair cartilage or cartilaginous injuries caused by the migration of mesenchymal stem cells following stimulation or microinjury. Hyalofast transplant is indicated in cases of OLT grade III and IV according to ICRS classification. There may be one or more injury sites with these injuries caused by recent trauma, repeated microtrauma, instability and/or misalignment, and osteochondritis dissecans (OCD).

In this study, we also used Hyalofast, which is a 3D structural artificial articular cartilage product, 100% composition from Hyalorunic acid-HA of non-animal origin (fermented from cells), precisely a 3D support frame by Hyaff® (benzyl ester of Hyalorunic acid-HA). During surgery, combined with micro-injury, it will stimulate and create a framework for mesenchymal stem cells (MSCs) to regenerate hyaline joint cartilage.

Follow-up results after six months showed that AOFAS in three patients increased from about 57 to 61 points to about 91 to 100 points. MRI evaluation six months after surgery also showed

almost complete coverage of the "new cartilage" on the lesion surface. The surgery must ensure that the artificial material is inserted inside and evenly spread over the lesion surface when the ankle joint is "dry". With the advantages of Hyalufast, including high adhesion and easy thinning, this can be done relatively quickly. Postoperative immobilization for 2 to 3 weeks ensures the graft does not move from its original position. Our results are consistent with Battaglia M (2011) bone marrow-derived cell transplantation for 20 patients with OLT. Follow-up after two years showed an increase in AOFAS score from 66.8 ± 14,5 to 91.2 ± 8.3. Evaluation by T2-mapped MRI revealed new hyaline cartilage formation and covered an average of 78% of the damaged cartilage [6].

Compared with other authors, studies on grafting Hyalofast in combination with mesenchymal stem cells show that the hyaline cartilage regeneration process confirmed by T2 MRI has many advantages over other methods, such as creating micro-lesion or simple micro-lesion. Gobbi A. (2016) compared the results when grafting a scaffold attached with hyaluronic acid and concentrated bone marrow cells with simple micro-injury in 50 patients (average age 45) with knee cartilage damage from 1.5-24 cm^2. At the 2-year follow-up, on the IKDC scale, 64% of the microlesion group had normal and near-normal results compared with 100% of the hyaluronic acid-affixed scaffold and bone marrow cell concentrate group. After five years, this rate in the microlesion group dropped to 28%, while the transplant group maintained good results. Poor results were seen in the micro-lesion group when the cartilaginous defect size was over 4 cm2 and many defects were found but not related to the age of over 45 years, significant cartilage defects, and multiple defects in the hyaluronic acid scaffold graft group and concentrated bone marrow cells [7].

The clinical outcome of the meantime follow-up of the transplant group was also better than that of simple microlesion and nanofracture. Tahta M. (2017) compared the results of 2 groups undergoing ankle arthroscopy to treat OLT, including 46 patients with hyaluronic acid scaffold - autologous bone marrow cell concentrate with 52 patients created nanofracture, similar in age, BMI, defect size and depth, follow-up time, the results showed that VAS, AOFAS scores were better in the group of hyaluronic acid-cell scaffold grafts. Autologous bone marrow concentrate. In particular, cartilage quality is much higher according to the MOCART (magnetic resonance observation of cartilage repair tissue) score [8].

In another study, treating cartilaginous ankle and knee injuries, including OCD in young people, still showed excellent clinical and MRI results with medium-term follow-up. Buda R. (2013) One-stage laparoscopic surgery, grafting a scaffold with bone marrow mesenchymal stem cells taken from the posterior iliac crest for 30 patients with knee osteoarthritis. The average postoperative IKDC score was 85.4 ± 4.2 compared with preoperatively 29.9 ± 13.2, and the postoperative KOOS score was 87.3 ± 7.3 compared with pre-operative 35.1 ± 11.9 with a mean follow-up of 29 ± 4.1 months. MRI images and postoperative biopsies also showed new articular cartilage regeneration at the injury site [9].

With a long-term follow-up from 6 to 10 years, it shows good and very good results in cases of severe cartilage damage. Gobbi A. (2019) long-term follow-up for eight years (6-10 years) 23 cases, average age 48.5, with average knee cartilage damage of 6.5 cm2 (2-27 cm^2) after grafting of a hyaluronic acid scaffold with concentrated bone marrow cells. The results showed that the mean Tegner, VAS, and IKDC scores were 4, 0.3, and 85. Average KOOS scores: pain 94, symptoms 89, daily activities 99, sports 85, quality of life 85 and all improved. Markedly improved compared to before surgery [10].

Figure 7. A 32-year-old male patient, was checked six months after surgery

Conclusion

Arthroscopy using hyaluronic acid-based scaffold implantation with microfracture to treat the OLT initially brought positive results, helping patients improve pain symptoms and return to daily life. However, in the future, more studies with larger sample sizes and longer follow-up times are needed to evaluate the results of this method.

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