

Bipolar Fresh Osteochondral Allograft for the Treatment of Hallux Rigidus

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The term *hallux rigidus* is used to describe a condition characterized by pain and reduction of motion, especially in dorsiflexion, at the first metatarsophalangeal (1MTP) joint due to arthritis occurrence.^{3,23,28} The indication for surgery is pain combined with degenerative changes of the 1MTP joint. The surgical strategy has to be planned according to the degree of arthritis and is aimed to relieve pain, improve function, reduce the progression of arthritis, and correct any associated deformity.^{26,12}

Although different surgical strategies have been proposed in order to spare the 1MTP joint, in the presence of end-stage arthritis, the most reliable solutions remain arthrodesis, interpositional arthroplasty, and prosthetic replacement. Arthrodesis provides satisfactory results for both patients and surgeons; nevertheless, it is not always well accepted by the patient.^{5,6,16,19,22,25} A possible alternative is a resorbable implant that during reabsorption forms fibrous tissue that maintains the stability and length of the toe.¹² Prosthetic replacement of the 1MTP joint may represent an option but, despite a large number of different designs proposed over time, is prone to failure in the mid-term and has a high rate of complications.^{1,7,9,16-18,27}

Bipolar fresh osteochondral allograft (BFOA) was first used for the treatment of end-stage arthritis in the ankle joint and represents a fascinating option for biological joint reconstruction.^{2,4,8,13-15}

The aim of this study was to describe 6 cases of total BFOA used for the treatment of hallux rigidus with end-stage arthritis and to report the clinical and radiographic results obtained at a mean of 6 years of follow-up.

Case Reports

Four female patients (6 feet) affected by end-stage hallux rigidus received BFOA. Mean age was 51.0 ± 18.6 years. Preoperative evaluation included the recording of the complete history of the patient and a careful physical and radiographic examination. Clinical evaluation was performed using the American Orthopaedic Foot & Ankle Society



Figure 1. Preoperative radiographs showing bilateral hallux rigidus with end-stage arthritis.

(AOFAS) score.²¹ The mean preoperative range of motion (ROM) was 20.3 ± 2.6 degrees. Radiographic evaluation included standard anteroposterior and lateral radiographs of the foot (Figure 1) aimed to help surgeons to determine the appropriate size of the allograft to be implanted. The donor was identified through the bone bank program for musculo-skeletal tissue transplantation.

With a standard surgical procedure, the entire 1MTP joint was harvested en bloc from the donor, with care taken to leave the capsule intact. Once harvested, the joint was placed in a sterile container with L-glutamine, NaHCO_3 , and antibiotics solution and stored at 4°C . Allograft implantation was performed at a mean of 9.6 ± 4.3 days (minimum 4 days, maximum 14) from harvesting.¹³⁻¹⁵

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Figure 2. Articular graft surfaces accurately cut preserving 10 to 12 mm of subchondral bone.

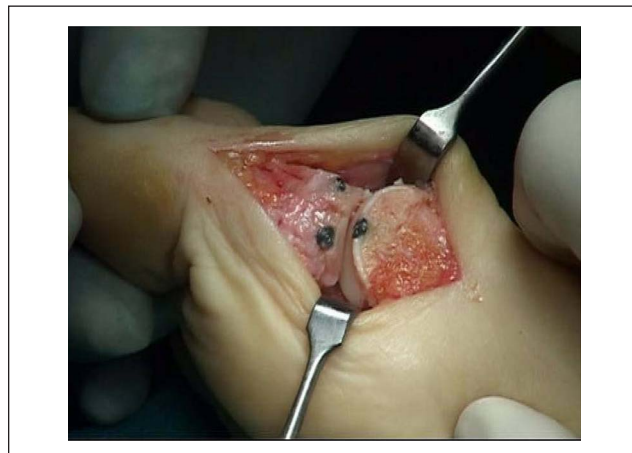


Figure 3. Photograph showing allograft surfaces inserted and fixed in place with twist-off screws.

The surgical session consisted of 2 steps: the first for the graft preparation and the second for the graft implantation.

Step 1. On a separate surgical table, all soft tissues were carefully removed from the harvested 1MTP joint, taking care not to damage the articular cartilage. Then the articular surfaces of the metatarsal and of the phalanx were accurately cut with a standard pneumatic saw, taking care to mark with a sterile pen the medial side of the joint. The whole articular surfaces were maintained intact, preserving about 10 to 12 mm of subchondral bone (Figure 2). The prepared articular surfaces were then temporarily placed in a container with saline solution.

Step 2. The patient was placed in supine position under spinal anesthesia. A standard medial incision to the 1MTP joint was used. The amount of joint to be resected and the direction of the cut were marked, under fluoroscopic control, from medial to lateral with 2 Kirschner wires as planned on the basis of the preoperative radiographs. The cut was then performed parallel to the K-wires with a standard pneumatic saw, and the articular surfaces were removed.

The allograft surfaces were then inserted and fixed in place with twist-off screws (Figure 3). Fluoroscopic control was performed to verify the correct placement of the graft; moreover, the ROM of the MTP joint was checked. The mean range of motion before soft tissues closure was 64.2 ± 3.7 degrees. Postoperative radiographs were taken and a soft dressing was applied for 20 days.

For the first month, a talus shoe was used to allow heel weight-bearing. After 1 month, passive mobilization of the 1MTP joint was started and a standard, comfortable shoe was permitted.

The patients were checked at 1, 3, 6, and 12 months after surgery and then yearly up to the mean final follow-up of 72 ± 6.1 months. Postoperative evaluation was carried out clinically (AOFAS score) and radiographically.

Results

No intraoperative complications occurred.

A major complication with soft tissue dehiscence and infection was observed in the early postoperative period, bilaterally, in 1 patient. This patient had significant shortening of the first rays as a complication of a previous surgery for hallux valgus correction. Allografts were removed, and after infection eradication, skin coverage and first metatarsal lengthening with external fixators have been performed.

The remaining 3 patients (4 feet) were satisfied with the results obtained. At final follow-up, the mean painless ROM of the 1MTP joint was 37.6 ± 11 degrees. The AOFAS score increased from 28.7 ± 4.1 points preoperatively to 87.2 ± 2.6 points at the final follow-up. Radiographically, arthritis was evident at final follow-up (Figure 5) compared with initial postoperative radiographs (Figure 4).

Discussion

Arthrodesis of the 1MTP joint is the most frequently indicated treatment for end-stage hallux rigidus, and the results are widely described as satisfactory.^{5,6,16,19,22,25} Nevertheless, the loss of joint movement, with the need for a flat shoe, may not be accepted, particularly by female patients. The unsatisfactory results and the high rate of complications observed with the use of a prosthesis prompted the search for joint biological repair.

The BFOA is a biological resurfacing of a degenerated joint and may represent a fascinating alternative to traditional



Figure 4. Postoperative radiographs showing the correct positioning of the graft.



Figure 5. Radiographs at 40 months follow-up showing mild arthritis.

prosthetic substitution.¹³ The applicability of BFOA has been described for the treatment of end-stage ankle arthritis and can provide satisfactory clinical results, despite a high rate of described complications.^{2,13,20,24,29} In a series reported by Giannini et al¹³ on 32 ankle allografts, the overall clinical results were satisfactory and there was a significant improvement of the AOFAS score from a preoperative of 33.1 ± 10.9 to 69.5 ± 19.4 at 31 months follow-up. Nevertheless, 6 failures were described and radiographic signs of degeneration of the graft were evident in all the cases. Recently, a case report described the use of BFOA to revise a painful ankle arthrodesis with satisfactory result at 44 months follow-up.¹⁵ BFOA has also been applied to the shoulder with good clinical results, even though the radiographic aspect of

the graft at follow-up showed arthritis and partial reabsorption of the newly implanted surfaces.¹⁴

To our knowledge this is the first report on the use of BFOA for the treatment of hallux rigidus, and the results were satisfactory in 3 of the 4 patients operated. The occurrence of a major complication with infection and wound dehiscence was a unique case in our experience with BFOA.¹³⁻¹⁵ This bilateral failure of the implant may be related to a technical mistake. In fact, both the first rays of the patient, shortened by previous surgery, were elongated by the interposition of the allograft. This may have caused a damage to the vascular supply of the skin, leading to the dehiscence of the wound and finally to allograft failure. Cases of dehiscence without infection and no need of revision were experienced by the authors with the use of the resorbable spacer for the treatment of hallux rigidus using the same material as used in arthroereisis, where the rate of dehiscence is negligible.^{10,11} This complication may suggest that the 1MTP joint is an area that does not tolerate the introduction of materials to be progressively replaced, possibly because the inflammatory reaction occurs superficially, due to the small amount of soft tissues covering the 1MTP joint.

Patients were satisfied with the clinical results obtained. The final range of motion of the 1MTP joint obtained in this series at follow-up was limited but still adequate for the patients' satisfaction and quality of life.

In conclusion, the use of a BFOA in the treatment of hallux rigidus is an expensive and demanding procedure requiring a strict collaboration with a tissue bank and dedicated lists for patients aimed to implant the harvested grafts within 15 days. For these reasons we are aware that this is not a technique that could be widely adopted today. Furthermore, the conversion of BFOA into arthrodesis would be more complicated. However, we believe that BFOA may be considered as an alternative to prosthetic replacement when the patient has normal structure of the first ray and does not wish to undergo a fusion, even though arthrodesis remains the technique with the most consistent results reported in the literature.^{16,19,22,25}

Declaration of Conflicting Interests

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