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Bipolar fresh total osteochondral allograft in the ankle: Is it a successful long-term solution?

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ABSTRACT

Introduction: Severe post-traumatic ankle arthritis poses a reconstructive challenge in young and active patients. Although technically demanding and despite unsolved immunological issues, bipolar fresh total osteochondral allograft (BFTOA) represent an intriguing option to arthrodesis and prosthetic replacement. The purpose of this paper is to evaluate the outcomes of a series of 48 ankle BFTOA at 10 years follow up and to investigate the rate of survival long term.
Methods: 58 patients underwent BFTOA, of these 48 were available for follow up. The allograft was prepared with the help of specifically designed jigs and the surgery was performed using either a lateral or a direct anterior approach. Patients were evaluated clinically and radiographically preoperatively, and at a mean 121 ± 18 months of follow-up.
Results: The AOFAS score improved from 31 ± 11 pre operatively, to 65 ± 25 at the last ($p < 0.0005$). Fourteen failures occurred, with 70.8% allograft rate of survival. All the surviving allografts showed a reduction of the ankle joint movement, still associated with a satisfactory clinical result.
Conclusion: The use of BFTOA represents an intriguing option to arthrodesis or arthroplasty. A satisfactory clinical result associated to a good movement of the transplanted joint is to be expected up to short-mid-term, overtime. Long term, the range of motion (ROM) is progressively decreased up to spontaneous arthrodesis in some cases, still the joint results pain free and patient's perception is of a well functioning ankle. A deeper knowledge of the immunological behavior of transplanted cartilage is needed in order to improve the durability of this fascinating technique.

Introduction

Post-traumatic osteoarthritis treatment still represents a challenge in young active patients. Surgical treatment is usually represented by arthroplasty or arthrodesis, depending on the anatomical site involved. However, the progressive and inevitable prosthesis loosening over time together with the limited applicability of arthrodesis and the concerns related to its functional and psychological limitations associated, have driven researches toward biological solutions [1–5].

While there is agreement in literature on the validity of partial allografts, controversial results are reported with the use of bipolar fresh total osteochondral allograft (BFTOA) in several anatomical districts such as knee and shoulder [6–13].

Compared to other sites of application, Ankle BFTOA transplantation have shown in a few reports to be capable to provide a sort of biological prosthesis progressively integrated by the host and to be a fascinating alternative to arthrodesis and prosthetic replacement [5,14–16].

The rationale at the base of allograft transplantation is to implant a viable osteochondral segment, capable to survive the transplantation and to be fully integrated by the host. Nevertheless, cartilage and bone are different tissues, and once transplanted they follows different paths. The newly implanted bone, in fact, is considered nonviable and relies on the host for vascular invasion with subsequent osteoclastic reabsorption and replacement with new viable bone (creeping substitution) [17,18].

Otherwise the behavior of the articular cartilage is not completely known. Articular cartilage is normally avascular, aneural, and alymphatic, and cells are embedded in an acellular matrix which is believed to protect them from host immunogenic cells [19].

To date BFTOA in the ankle joint is a technically demanding procedure with reported intraoperative and postoperative

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complications, associated with controversies in the indications and outcomes [5].

Different techniques are reported for BFTOA procedure in the ankle using either an anterior approach, with the help of ankle prosthesis instrumentation, and a lateral transmalleolar one [14–16,20–22].

The purpose of this study is to evaluate the clinical and radiographic long term outcomes in a consecutive series of patients undergoing a bipolar osteochondral allograft transplantation for advanced ankle arthritis.

Material and methods

From August 2004 to April 2009, 58 patients underwent BFTOA for end-stage post-traumatic ankle osteoarthritis. Thirty-two patients received the allograft from a lateral approach while 26 received the allograft from anterior approach.

Forty-eight patients, 36 males and 12 females (mean age 36 ± 8, range 17–55) were available for follow up at 121 ± 18 months follow up (range 91–149).

Inclusion criteria were patients less than 50 years with unilateral ankle arthritis grade III [18] with pain unresponsive to a minimum of 6 months of medical and physical therapies including limiting the activities of daily living. Contraindications for surgery included inflammatory rheumatic disease, infections, reflex sympathetic dystrophy, osteopenia, vascular and neurologic diseases. Lower limb malalignment and chronic instability were addressed surgically before or during the transplantation procedure.

Ten patients received a sight immunosuppressive protocol with Cyclosporine 3 mg/kg/die for 6 months, Deltacortene: 10 mh/die for the first month and then 5 mg/die for 2 months, according to a protocol used for rheumatologic patients in the Rizzoli Institute rheumatologic department. These patients received immunosuppressive therapy since included in a comparative study, still unpublished.

Twenty-three percutaneous Achilles lengthening for Achilles contracture, one tenotomy of the flexor digitorum longus of the first ray and two peroneal tenodesis were performed as associated procedure during allograft transplantation; in three cases a first metatarsal osteotomy and a tenotomy of the extensor digitorum longus tendons was performed for cavus foot correction; in one case a subtalar mini-bone-block distraction arthrodesis was performed for flat foot correction with subtalar arthritis [23].

Patients were evaluated before surgery by means of physical examination, weight bearing radiographs, and the American Orthopaedic Foot and Ankle Society hindfoot score (AOFAS) [24].

Plain antero-posterior and lateral weight bearing radiographs and a CT scan of the affected ankle were taken. The size of the patients' ankle was digitally measured on the CT scans. Candidates were then placed in a waiting list until an appropriate sized donor become available.

Fresh anatomically appropriate tissue was obtained from healthy donors who met the criteria of the Bone Bank program for tissue donation.

Allograft were harvested within 24 h from death and were transplanted fresh less than 14 days from procurement. Harvesting of the ankle from the donor involved excision of the entire joint with an intact capsule and synovial membrane. Grafts were then placed in a sterile plastic bags and immersed in a solution containing L-glutamine, $NaHCO_3$ and antibiotics. These harvested tissues were stored in plastic containers 4 °C degrees until transplantation. The size of the donor tibia and talus was measured using CT scans and appropriate candidate was selected upon the ankle size.

The study was approved by the Ethics Committee of the Authors' institution and informed consent was obtained from all patients after extensive discussions about the various risks, benefits, and alternatives to fresh osteochondral allografting.

Surgical technique

Surgical treatment was performed in two steps, one for the graft preparation and the other for surgery in the recipient.

On a separate table, the harvested ankle had all soft tissues removed. Care was taken not to damage the cartilage surface. The fibula was removed and the medial malleolus surface was cut with the help of a specifically designed jig held in place by a K wire. Then, the tibial surface was first prepared either by a curved cut in lateral view, for the cases to be implanted by a lateral approach or by using two 2 mm K-wires in order to define the planes of cut and a standard pneumatic saw, for the graft to be implanted from anterior. The cut was performed at a proper level in order to obtain a 1 cm thick osteochondral surface. The talar surface was then prepared with the same method, taking care to obtain a 1 cm thick talar dome surface (in its central portion) as well. The articular surfaces obtained were placed in a saline solution during the host implant site preparation.

The patient was placed supine under general or spinal anesthesia with a thigh tourniquet.

In the first group of cases (lateral approach), a dorsal longitudinal three cm skin incision medial to the tibialis anterior was performed and the medial malleolus internal surface was exposed. The internal surface of the medial malleolus was then prepared by using a probe-jig, stabilized with a two mm K-wire and a standard pneumatic saw.

A lateral incision to the fibula was then carried out. A fibular osteotomy was performed and the fibula was reflected externally exposing the lateral aspect of the ankle. Using the same sized probe utilized for preparing the graft, the curved jig for the tibial cut was positioned at the proper level and the talar cut was performed by using a standard pneumatic saw.

The cut of the distal tibia was then performed by multiple K-wire perforations, through the specific jig and completed with the curved chisels. The allograft surfaces were positioned in the host ankle, and by moving the ankle from dorsiflexion to plantarflexion a free of overloads positioning of the components is obtained. The allografts were fixed with 14–18 mm twist-off screws. Finally, range of motion of the ankle was checked in dorsiflexion and plantarflexion.

In the cases operated from anterior, the ankle joint was approached through an anterior midline incision between the extensor hallucis longus and tibialis anterior tendons. The medial malleolar surface is prepared with the help of the same specifically designed jig previously used for the cut of the donor surfaces. Then, two 2 mm K-wires were positioned and checked by fluoroscopy both on the tibia and the talus at the same distance from the joint line used in preparing the graft and both the distal tibial and talar surfaces were cut and removed.

Allograft surfaces were positioned in the host ankle and fixed by 2 standard titanium screws, while either twist-off screws (De Puy Orthopaedics Inc, Warsaw, USA) or Herbert screws were used for talar fixation (Zimmer Inc, Warsaw, USA).

Finally, the ankle was tested for range of motion in dorsiflexion and plantarflexion and for stability.

The tourniquet was deflated and a haemostasis was performed. Finally, the ankle joint capsule was closed over the allograft after implantation, followed by skin closure. Postoperative X-Rays were then taken.

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