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Total joint reconstruction of the arthritic ankle joint using bipolar shell allograft

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Post-traumatic arthritis of the ankle in the young and active patient represents a reconstructive challenge. Ankle arthrodesis provides satisfactory pain relief but functional and psychological limitations are reported. Furthermore, inevitable loosening of joint arthroplasty in a young and active population has lead in the search for a biologic method of repair. The use of frozen allografts as limb salvage surgery for malignant bone tumors, alone or in association with prosthesis as a modular versatile and durable solution to the resected bone segment with limited immunogenic risk, is well documented. More recently, the institution of large institutional bone banks allowed for further research in the biology of allografts, significantly extending their applicability. Fresh osteochondral allografts would provide viable cartilage that can survive transplantation and bone that would provide an intact structure until host bone replaces it. This approach is intriguing and increasingly popular since it can provide a reconstructive solution for younger and higher demanding patients where implants are not desirable and arthrodesis is not acceptable. The purpose of this study is to describe the preliminary results of a series of 25 bipolar shell ankle allografts performed by using a specifically designed instrumentation.

25 patients, 18 males and 7 females (mean age 32±11 years) affected by post traumatic arthritis of the unilateral ankle joint grade III, received bipolar shell allograft of the ankle. The ideal patient to allograft match was permitted through CT scan and x-rays. Patient evaluation was carried out clinically by AOFAS and radiographically by x-rays, CT scans, and MRI. The preoperative evaluation included acquiring a complete history of the patient and a physical and radiographic examination. The history and nature of the ankle trauma and previous treatments attempted were recorded. The ankle was checked for instability, malaligment, and ROM. A panoramic radiographic examination of the lower limbs, including antero-posterior and lateral weight-bearing views of both ankles and a CT scan of the affected joint were taken. Candidates were then placed in a waiting list until an appropriate size donor became available. Donors were identified through the Bone Bank program for tissue donation. Prior to surgery, the size of the donor tibia and talus was matched to the host using radiographs and CT scans. No tissue or blood type matching was performed. Harvesting of the ankle from the donor involved excision of the entire joint with an intact capsule and synovial membrane. The ankle was then placed in a sterile container with L-glutamine, $NaHCO_3$ and antibiotics solution. This was then stored at 4°C until transplantation (within 14 days). A CT scan of the harvested ankle was performed in order to obtain standard measurements. On the basis of the measurements obtained, the compatible patients were individualized from a computerized database. Surgical procedure: Surgical treatment was performed in two steps, one for the graft preparation and the other for surgery in the recipient. First step surgery: On a separate table, the harvested ankle had all soft tissue removed. By using the specifically designed jigs, the allograft was prepared. Second step surgery: The patient was placed in supine position with tourniquet at the thigh. The internal surface of the medial malleolus was prepared by using a probe-jig and a standard pneumatic saw. 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 cut of the distal tibia was then performed, followed by the talar surface cut. The damaged joint surfaces were then removed and the allograft surfaces were positioned in the host ankle, ensuring that the ankle permits a natural and free of overload positioning of the components. The allografts are fixed with 14-18 mm twist-off screws. Rehabilitation protocol: plaster cast was applied for 15 days. Continuous passive motion (CPM) was advised the day after cast removal. Walking with crutches and no weight bearing on the affected ankle was also advised. Partial weight bearing was permitted 4 months after surgery if radiological signs of healing are visible, and 6-8 months after surgery complete weight bearing was advised.

The mean follow-up was 20 months (range 32-8). A medial malleolar fracture occurred as an intraoperative complication. All the patients demonstrated good consolidation rates of the allograft at x-rays, CT scan, and MRI controls performed at 4, 6, 8, and 12 months, at an average of 5 months. At 6 months follow-up, all the patients were allowed complete weight bearing. Normal ROM of the ankle and regular gait with no pain and no need of support was resumed in 23 patients. In two patients, a fracture of the fibula was reported. In one case, cause of the fracture was patient non-compliance to the weight-bearing restriction. In the other case, the fracture occurred distally to the osteotomy site, possibly due to trauma. Both cases required revision of the graft that appeared damaged in the lateral site. In the first case, an ankle arthrodesis was performed. One case was lost at follow-up. A bioptic harvest of the transplanted cartilage in 16 patients at 1 year follow up demonstrated chondrocytes vitality > 90%.

The rationale for fresh osteochondral allograft is clinical and experimental evidence of maintenance of viability and function of the chondrocytes after transplant also confirmed at long term. Furthermore, the bony parts of allograft are progressively replaced by host bone in 2-3 years. The fresh osteochondral allograft is becoming increasingly popular for the treatment of ankle arthritis in the young and active patient, even if it is a very technically demanding technique and a high percentage of complications and failure have been reported. The technique described has the advantage of dramatically reducing the possibility of incongruence between the graft and the host. The use of specifically designed jigs permits the implantation of a complete osteoarticualar surface. Furthermore, the curved cut of the tibia, obtained through the lateral access, provides extensive contact surface and good stability of the graft, with consequent reduced need of fixation devices. By using this technique, it is easier to obtain a congruent allograft of proper thickness and appropriate fit. Close attention must also be paid to patient selection, previous correction of joint malaligment, and stable but minimal internal fixation of the allograft to the host. Under no circumstance should the height of the graft be used to correct malaligment of the limb and maximum graft thickness should be 1 cm. In conclusion, fresh total shell osteochondral allograft of the ankle, although technically demanding, is a viable alternative to arthrodesis or arthroplasty in individuals with advanced ankle arthritis. The technique presented, with the use of the newly developed jigs, represents an improvement in allowing a precise and reproducible procedure with the possibility of modular cuts. Although preliminary results are encouraging, longer follow-up is required in order to confirm longer term cartilage viability and the validity of the technique.