Foot and Ankle Surgery xxx (2016) xxx–xxx

Contents lists available at ScienceDirect

Foot and Ankle Surgery

journal homepage: www.elsevier.com/locate/fas

Biological reconstruction of large osteochondral lesions of the talar dome with a modified "sandwich" technique—Midterm results

Boguslaw Sadlik, MD, PhD[a], Lukasz Kolodziej, MD, PhD[b,*], Adrian Blasiak, MD, PhD[a], Mateusz Szymczak, MD[c], Bartłomiej Warchal, MD[a]

[a] Biologic Joint Reconstruction Department, St Luke's Hospital, Bielsko-Biala, Poland
[b] Orthopaedic, Traumatology and Orthopaedic Oncology Clinic, Pomeranian Medical University, Unii Lubelskiej 1 Str., 71-252 Szczecin, Poland
[c] Orthopaedic Department, Nicolaus Copernicus Hospital, Torun, Poland

ARTICLE INFO

Article history:
Received 7 February 2016
Received in revised form 4 September 2016
Accepted 5 September 2016
Available online xxx

Keywords:
Cartilage repair
Medial malleolar osteotomy
Osteochondral lesion
Talar dome
Sandwich technique

ABSTRACT

Background: Surgical treatment for large osteochondral lesions of the talar dome (OLTD) must restore the convexity and curvature of the talus. Here, we present midterm results and describe the modified "sandwich" reconstruction procedure. Bone defects were restored using a biological inlay consists of autologous bone chips that were mixed with bone marrow concentrate and fibrin glue and covered with a xenogeneic collagen membrane infiltrated with bone marrow concentrate and stabilized by fibrin glue.
Methods: Ten patients who were treated using a modified "sandwich" OLTD reconstruction were assessed after an average follow-up period of 46.4 (±18) months, using the clinical American Orthopaedic Foot and Ankle Society Ankle Hindfoot Scale (AOFAS) score and radiological magnetic resonance observation of cartilage repair tissue (MOCART) score.
Results: The mean AOFAS score increased significantly from 58.3 (±8.5) points to 81.8 (±15.5) points as well the mean VAS score reduced significantly from 5.58 (±0.97) to 1.83 (±0.93) points. The average MOCART score was 69.5% (±16.7%) in the final follow-up.
Conclusions: The presented modified "sandwich" technique permanently recreates the convexity and curvature in large osteochondral lesions of the talar dome with a single step surgical procedure.

1. Introduction

Osteochondral lesions of the talar dome may develop when there is idiopathic necrosis of cartilage and bone (osteochondritis dissecans—OCD), subchondral cysts, posttraumatic focal necrosis, trauma, or repetitive microdamages [1,2]. Small osteochondral lesions of the talar dome are successfully treated arthroscopically with a bone marrow stimulation technique (BMST). In case of traumatic fracture of a large osteochondral fragment, an arthrotomy and reimplantation of a broken piece of the articular surface is recommended [3–6]. More extensive lesions of the articular surface require the use of a regenerative method, which is based on covering the lesion with a matrix containing autologous chondrocytes (ACI) or bone marrow mesenchymal stem cells (MSCs) [5,7–9]. The large osteochondral defect of the talar dome is a difficult therapeutic problem, as it requires restoration of damaged layers of both bone and cartilage [10]. According to numerous authors, the treatment of large osteochondral lesions with osteochondral autologous transposition (OAT) gives very good results [11], but critics of this method are concerned that the healthy knee joint has to be breached to obtain the osteochondral graft, and that there will be problems obtaining the native curvature of the articular surface on the talar dome [12]. Another significant disadvantage of the OAT technique is a lack of full integration of the transplanted block with the surrounding bone and cartilage [10,12]. The dual-layer reconstruction of an osteochondral lesion that recreates the specific shape of the surface is known as the "sandwich" technique and involves the implantation of autologous bone chips and covering their surface with autologous chondrocyte cultures or an empty collagen matrix [13–15].

2. Materials and methods

Ten patients (six males and four females) were treated at our institution from January 2011 to August 2013. The average age at the time of surgery was 37 (±12.5) years. The average follow-up

* Corresponding author.
E-mail addresses: sadlik@lukasza.pl, sadlik@icloud.com (B. Sadlik), lukas@hot.pl, lukaskolodziej@hotmail.com (L. Kolodziej), blasiak@lukasza.pl (A. Blasiak), mat-sz@wp.pl (M. Szymczak), warchal@lukasz.pl (B. Warchal).

http://dx.doi.org/10.1016/j.fas.2016.09.001
1268-7731/

period was 46.4 (±18) months. The average BMI index of patients was 26.7 (±3.5) kg/m^2. There were seven right and three left ankle joints involved. The average calculated size of the defect was 132 (±59) mm^2. Two patients were treated unsuccessfully before the index procedure with arthroscopic microfracturation techniques. Clinical results were assessed with Visual Analog Score for pain evaluation (VAS) and American Orthopaedic Foot and Ankle Society Ankle Hindfoot Scale (AOFAS) [16]. Table 1 presents clinical and radiological variables of patients with osteochondral lesion of the medial talar dome. Bone healing of the osteotomy site was assessed in anteroposterior and lateral weight-bearing radiographs. The magnetic resonance observation of cartilage repair tissue (MOCART) score, which measures different variables to describe the constitution of the cartilage repair tissue and the surrounding structures, was used to evaluate the regenerative tissue fulfilling the talar defect [17]. In addition, patients were asked if they would undergo that procedure again or would recommend it to their relatives and family. All patients were treated using an identical surgical technique.

2.1. Surgical technique

The procedure started with aspiration of 30 ml of bone marrow from the iliac crest, using a set of MarrowStim (Biomet Warsaw, Indiana). After centrifugation and separation, about 4 ml of the bone marrow concentrate was obtained. Then, a medial malleolus chevron osteotomy was performed. The direction of the malleolus osteotomy was planned based on a coronal scan using magnetic resonance or computer tomography to determine the most convenient approach to the defect. The posterior tibial tendon had to be protected at the beginning of the osteotomy. Before debridement, it is recommended to use a piece of smooth material for joint protection against the falling tissue remnant. The cartilage around the lesion had to be cut perpendicularly to the bottom to form a vertical wall of healthy chondral tissue. To achieve vertical edges, according to Steadman's recommendation, a surgical knife blade number 11, a curette, and a small rounded chisel were used. The bottom of the lesion was abraded by burr-shaver, to achieve superficial bleeding vessels in the subchondral opening bone. Next, three low speed drills using a 1.6 mm diameter K-wire were made to a depth of about 10 mm (Fig. 1A). Autologous bone was harvested from the tuberosity of the ipsilateral tibia by creating a little window in the tibial cortex. Harvested bone chips were effectively crushed, and then approximately 1 cm^3 of bone marrow concentrate was added. A first portion of the mixture was compacted in the bottom of the lesion (Fig. 1B). A second portion of bone chips and MSCs had been mixed and drained off, then two or three drops of Tisseel (Baxter, Deerfield, IL, USA) fibrin glue were added and mixed again just before the application of the mixture into the defect (Fig. 2). The last portion of bone chips with MSCs and fibrin glue should reproduce the shape and curvature of the edge of the medial talar dome. This procedure is similar to creating a dental filling, which must be perfectly matched to the shape of the tooth. The formed seal was coated with a thin layer of fibrin glue. Dry arthroscopic imaging was used to provide an enlarged image and better visibility in this small operative area (Fig. 3). Collagen membrane (Chondro-Gide, Geistlich Pharma AG, Wolhusen, Switzerland) was matched to the defect and infiltrated with bone marrow concentrate. Then, the membrane was placed on the bone chips seal, and the edges sealed with fibrin glue (Figs. 1C and 4). The joint was closed and the medial malleolus was stabilized by two lag screws with 4.5 mm diameters (Fig. 1D). Hardware removal from medial malleolus were performed 12 months after surgery in all patients, before MRI examination which were reviewed for the evaluation of remodeling and bone ingrowth of the biological inlay at 12th month and 2 years postoperatively.

2.2. Postoperative care

Postoperative care consists of immobilization using a short-leg, non-weight-bearing casting for 2 weeks postoperatively, subsequently a walker (Aircast Walker, DJO Global, Vista, California) and functional physiotherapy with 15 kg partial weight bearing, maximal range of passive motion of 20° and lymphatic drainage massage for the next 4–6 weeks. This initial phase is followed by an intensive rehabilitation phase with progression to full weight bearing and strengthening of the ankle joint stabilizing lower leg muscles and proprioception training for the following 6 weeks (up to 12 weeks). The patients were seen in the outpatient clinic in 6th and 12th week after the surgery for a clinical follow-up examination and conventional radiographs. Routine weight-bearing radiographs (anteroposterior mortise and lateral views) were obtained in 6th and 12th week postoperatively. After 6 weeks, light sports exercising (swimming and cycling) were allowed. Return to competitive sports was preferred after 5–6 months. After

Table 1
Clinical and radiological variables of patients with osteochondral lesion of the medial talar dome; AOFAS—American Orthopaedic Foot and Ankle Society hindfoot scale; VAS—visual analog scale; MOCART—magnetic resonance observation of cartilage repair tissue; pre—preoperative; post—postoperative; y—yes; n—no; M—male; F—female; R—right; L—left; Arthr. Mfx—arthroscopical microfracture; ATFL—anterior talofibular ligament; TP—tibialis posterior; CFL—calcaneofibular ligament.

Case	Sex	Age	Smoker	BMI	Previous trauma	OCL size mm^2	OCL volume mm^3	Side	Previous surgery	Add procedure	VAS pre	VAS post	AOFAS pre	AOFAS post	MOCART final follow-up
1	M	21	n	29.8	y	120	600	R		ATFL repair	4.6	1.2	62	98	60
2	M	53	n	29	y	91	728	R			7	4.2	35	66	55
3	M	56	n	29.7	y	84	420	R		ATFL repair	5	1.4	47	72	65
4	M	52	n	25.5	n	280	3920	L			4.1	1.5	69	85	50
5	F	36	y	23.8	n	176	1232	L			6.2	1.5	69	83	45
6	F	25	n	29	n	117	702	R	Arthr. Mfx	TP repair after iatrogenic cut	5.5	2.5	39	63	90
7	M	29	n	21.8	y	84	504	R			4.8	1	65	92	80
8	F	33	n	31.8	y	144	720	R		Achilles elongational "Z" tenotomy	6.5	2	59	75	75
9	F	38	n	22.4	n	104	624	L	Arthr. Mfx		6.6	1.6	76	100	90
10	M	28	n	24.2	n	117	585	R		ATFL, CFL reconstruction	5.5	1.4	62	84	85
Average	4F/6M	37.1	1y/9n	26.7	5y/5n	131.7	1003.5	7R/3L			5.58	1.83	58.3	81.8	69.5

Please cite this article in press as: B. Sadlik, et al., Biological reconstruction of large osteochondral lesions of the talar dome with a modified "sandwich" technique—Midterm results, Foot Ankle Surg (2016), http://dx.doi.org/10.1016/j.fas.2016.09.001