

CT arthrography for evaluation of autologous chondrocyte and chondral-inductor scaffold implantation in the osteochondral lesions of the talus

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Summary. *Purpose:* to analyse the findings of CT arthrography of the ankle, one year after the transplant of autologous chondrocytes in solution (ACI technique) and the covering with the only scaffold implantation of the osteochondral lesions of the talus, in comparison with the clinical evaluation of the ankle. *Methods:* This retrospective study includes 10 patients (6 male, 4 female, mean age 49.4, range 25-74 years) with an osteochondral lesion of the medial side of the talus, 4 pure chondrals, 6 osteochondrals, painful and limiting the articulation, who underwent ACI using autologous chondrocyte (5 cases) and a covering with the only scaffold implantation (5 cases), in patients who underwent multi-detector CT arthrography between April 2006 and December 2013, at least 12 months after the surgery. *Results:* Grade 0 was presented in 5 cases (50%), grade 1 in 2 cases (20%), grade 3 in 2 cases (20%) and grade 4 in 1 case (10%). Among the 5 cases even to 0 according to ICRS classification, the patient presented no symptoms in 4 out of 5 cases (80%); in 1 case, the patient presented post-operation pain of moderate entity due to the onset of adhesive capsulitis (20%). The 2 grade 1 patients, according to the ICRS classification, did not report any post-operation pain (0%). The 2 grade 3 patients, according to the ICRS classification, reported a light pain in 1 case (50%). The grade 4 patient, according to the ICRS classification, reported moderate pain (100%). *Conclusions:* The CT arthrography, for the elevate spatial and contrast resolution, is a very accurate exam in detecting irregularities in the chondral-inductor scaffold implantation, and in correlating the clinical presentation. (www.actabiomedica.it)

Key words: CT arthrography, osteochondral lesions, talus

Introduction

The pathology of the ankle's cartilage is particularly frequent between the 4th and the 5th decade, with a prevalence in males (1); it can be attributed to deficit primitive forms of vascular supply or secondary forms, more frequent, caused by traumas, chronic ligament instability, axial alteration of the inferior limb (1).

From an anatomical-pathological point of view they can be divided into pure chondral lesions (con-

tusions; fractures) and Osteochondral lesions, divided in acute (like impact fractures, osteochondral fractures involving the sub-chondral bone) and chronic (2).

In the subjects with chondral or osteochondral lesions of the talus, the persistence of pain and the articular deficit suggest a reparation of the damage by surgery (1-2).

Through the years, numerous surgery techniques have been described both open cast and in arthroscopy with the aim of reducing the symptomatology, of

promoting an adequate reparation of the lesion, with regeneration of a tissue with biomechanical characteristics similar to the damaged one (3-5).

The different surgery techniques proposed can be, generally, divided into two groups:

- Reparative techniques, which aim at stimulating the formation of a reparative sub-cartilaginous tissue: articular debridement, Levy's superficial abrasions, Pride's sub-chondral perforations, chondroabrasions, micro fractures (4-6).
- Regenerative techniques of biological substitution of the cartilage tissue: mosaicplasty, transplant del perichondrium or of periosteum, transplants of autologous chondrocytes in solution (ACI technique), or on three-dimensional scaffold (MACI Techniques, Hyalograft C), covering with only scaffold (engineered tissue) (4-6).

The survey aimed at analysing the aspects of CT arthrography of the ankle one year after the transplant of autologous chondrocytes in solution (ACI technique) or covering with the only scaffold implantation, of the osteochondral lesions of the talus, in comparison with the clinical evaluation of the ankle.

Materials and methods

The hospital ethic board did not require any patient approval or informed consent for this retrospective review of case records.

This retrospective study includes 10 patients (6 male, 4 female, mean age 49.4, range 25-74 years) with an osteochondral lesion of the medial side of the talus, 4 pure chondrals, 6 osteochondrals, painful and limiting the articulation, who underwent ACI using autologous chondrocyte (5 cases) and a covering with the only scaffold implantation (5 cases), in patients who underwent multi-detector CT arthrography between April 2006 and December 2013 at a tertiary-care, at least 12 months after the surgery.

Inclusion criteria were prior autologous chondrocyte implantation or chondral-inductor scaffold implantation, in the osteochondral lesion of the talus.

The generally used surgery access was the mini arthrotomy, with antero-medial or antero-lateral cutaneous incision of 2 cm.

The post-operative period implies 15-20 days of immobilization with resin valve and limb discharge, and 7 more days of active and passive mobilization in discharge and the following recovery of the direct charge.

The ankle was injected with iodinate contrast material (Iomeron 300, Bracco SPA, Italy) after it was locally prepared with topical iodine and a local anaesthetic (2-3 mL of lidocaine) was applied to the skin. A 20-gauge was introduced into the ankle joint via an anterior approach with CT guidance, and 9-12 mL of contrast material was injected. The patient was then asked to flex and extend the ankle to facilitate even distribution of the contrast material throughout the joint.

Image acquisition

The patients were imaged with a 64-detector CT scanner (Somatom Sensation Cardiac 64; Siemens Medical System, Forchheim, Germany). All subjects were imaged while in the supine position, with the examined ankle in the centre of the gantry.

For data acquisition, a section of collimation of 64 x 0.6 mm, a section width of 0.6 mm, and a reconstruction increment of 0.3 mm were used. The pitch was 1.2, the tube current was 120 mAs, and the tube voltage was 120 kV.

The CT radiation dose was calculated on the basis of the Monte Carlo simulation by using a computer program (ImPACT CT Patient Dosimetry Calculator; ImPACT, London, England).

Image analysis

Review at workstation

For multidetector CT arthrographic data review, the images were downloaded to a Volume Zoom Wizard workstation (Siemens Medical Solutions). The reviewers created multiplanar reformatted images, including axial, coronal and sagittal reformatted images of the joints, at the workstation. The window settings for all images were adjusted for each patient by the reviewers.

Image review

Two musculoskeletal radiologists with 15 and 5 years of CT arthrography experience, respectively, re-

viewed all the imaging studies independently and categorized the defect chondral or osteo-chondral lesions, when present, according ICRS modified Arthro-CT classification of chondral lesions (7):

- Grade 0 or normal: no extension of contrast medium into chondral tissue.
- Grade 1 or almost normal: superficial chondral extension of contrast medium.
- Grade 2 or abnormal: extension <50% of thickness of contrast medium.
- Grade 3 or severe lesion: extension >50% of thickness of contrast medium or down to the calcified layer or down to the surface of the subchondral bone.
- Grade 4 or very severe lesion: penetration of contrast medium across the full diameter of the defect.

The CT images were performed after 12 months of chondral implantation.

The reviewers had access to patient identification and clinical data but were blinded to the initial clinical interpretation of the multidetector CT arthrograms. In cases in which the reviewers disagreed on the grade, a third, tie-breaking, reviewer provided the final classification. The third reviewer was a musculoskeletal radiologist with 12 years of experience. The third reviewer also had access to patient identification and clinical data but was blinded to the results of clinical data.

Clinical data were used as the reference standard for determining chondral abnormalities; in particular:

- *Good* tissue repair or not chondral lesion: absence of ankle pain with normal joint movement.
- *Partial* tissue repair or minimum chondral lesion: presence of occasional mild ankle pain with almost normal joint movement.
- *No* tissue repair: presence of ankle pain with limited joint movement.

Results

The Arthro-CT images of 10 of ten patients operated of autologous chondrocyte and chondral-inductor scaffold implantation have been double-blind checked, to evaluate chondral lesions, according to ICRS modified classification.

Grade 0 was presented in 5 cases (50%) (Fig. 1 A-B), grade 1 in 2 cases (20%) (Fig. 2), grade 3 in 2 cases (20%) (Fig. 3) and grade 4 in 1 case (10%) (Fig. 4) (Table 1).

Between the 2 cases of grade 3 according to the ICRS classification, the chondral defect was equivalent to 1.8 mm in one case, to 2.8 mm in the second case. In grade 4 the mdc surrounds the chondral defect affecting the bone interface (Fig. 4) (Table 1).

From a clinical point of view, among the 5 cases even to 0 according to ICRS classification, the patient presented no symptoms in 4 out of 5 cases (80%); in 1 case, the patient presented post-operation pain of

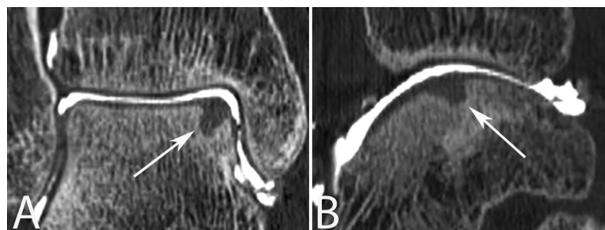


Figure 1. A-B. Arthro-CT of the right ankle, MPR coronal (A) and sagittal (B) image, in 25 years old male with result of autologous chondrocytes implant 12 months earlier, in result of focal osteonecrosis of the talus medial edge (arrows in A and B). Absence of chondral alterations, in agreement with grade 0 of the modified IRCS classification (arrows in A and B)

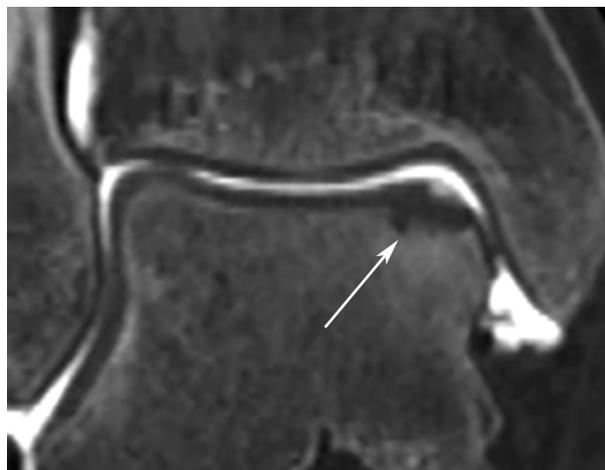


Figure 2. Arthro-CT of the right ankle, MPR coronal image, in 55 years old male with results of autologous chondrocytes implant 12 months earlier, in result of focal osteonecrosis of the talus medial edge. Focal and superficial mdc impregnation, in correspondence of the chondral implant, in agreement with grade 1 of the modified IRCS classification (arrow)

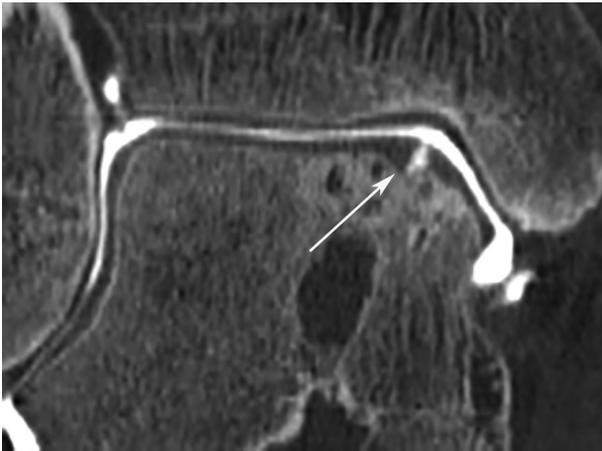


Figure 3. Arthro-CT of the right ankle, MPR coronal image, in 56 years old female with results of chondral scaffold implant 12 months earlier, in result of focal osteonecrosis of the talus medial edge. Focal mdc streak, of full thickness, in correspondence of the chondral implant, in agreement with grade 3 of the modified IRCS classification (arrow)



Figure 4. Arthro-CT of the right ankle, MPR sagittal image, in 36 years old female with results of chondral scaffold implant 12 months earlier, in result of focal osteonecrosis of the talus medial edge. Wide "chondral defect", in correspondence of the implant, in agreement with grade 4 of the modified IRCS classification (arrow)

moderate entity due to the onset of adhesive capsulitis (20%).

The 2 grade 1 patients, according to the ICRS classification, did not report any post-operation pain (0%). The 2 grade 3 patients, according to the ICRS

Table 1. Summarize of chondral lesions according to the ICRS system

Classification of Chondral lesions (ICRS)	Cases (%)
Grade 0	5 (50)
Grade 1	2 (20)
Grade 2	0 (0)
Grade 3	2 (20)
Grade 4	1 (10)

classification, reported a light pain in 1 case (50%). The grade 4 patient, according to the ICRS classification, reported moderate pain (100%).

There was 100% concordance between the two operators.

Overall, all of the 10 patients reported a benefice from the treatment (100%) and did not report any functional limitation after the operation.

Discussion

The Arthro-CT, in our experience, documented several aspects and a good concordance with the clinical grading in cartilage transplant of the talus, in absence of lesions and in high-grade chondral lesions.

The absence of alterations in Arthro-CT in asymptomatic patient, suggests that both the ACI technique and the scaffold implantation have determined a restitution ad integrum of the chondral damage.

The presence of high-level chondral alteration in Arthro-CT in symptomatic patient indicates the failing of the two surgery techniques.

The presence in Arthro-CT of small chondral alterations, after the implant of cartilage, does not strictly relate with the clinical evaluation.

The excellent spatial resolution of the CT, unitedly with the elevate contrast, provided by the arthrographic technique, makes such methodology particularly sensitive/sensible in reporting even very small cartilage irregularities, as widely demonstrated in literature (8-12), which nevertheless can recover with no pain symptomatology and with no significant articular deficit (8, 9).

In particular, we have observed that the chondral implantation, with presence of some superficial infil-

trations of mdc (grade 1 of Arthro-CT classification), relates with a good surgery result (Fig. 2).

The autologous chondrocyte and chondral-inductor scaffold implantation of the talus is a surgery technique, which presents great therapeutic results with scarce complication in the short term.

ACI is the implantation of in vitro cultured autologous chondrocytes using a periosteal tissue cover after the expansion of isolated chondrocytes (4). ACI has been popularized by Brittberg et al. and Petersen et al. since 1994 (3). The use of ACI technique is more frequent in knee (95%), less in the ankle (3%) or in other joints (2%) (4).

There are few studies about the use of the ACI as a treatment for cartilage defects in the other joints (4). However, based on promising early results with ACI in the knee, surgeons have now started to use ACI for osteochondral lesions of the talus (4, 13).

The defect should be focal, contained, and preferably more than 1.5 cm in diameter. Large lesions with sub-chondral cysts may be treated with ACI too, using the “sandwich technique”, i.e. filling the base of the defect with autologous cancellous bone (3, 13).

Contraindications to ACI are bipolar lesions (“kissing lesions”) and diffuse degenerative joint changes. Skeletal malignment and ligamentous instability are also contraindications, unless they are concomitantly corrected at the time of surgery (14, 15).

A limit of this surgical technique is given by the elevate costs of the cultivation in vitro of autologous chondrocytes; on the other hand, the results reported in literature regarding the use of the only scaffold can be considered good (14, 16).

A limit of Arthro-CT is the lack of evaluation of the osseous edema, which might be also present in absence of chondral lesions and explain the persistence of pain in the ankle after chondral implant. Another limit of our study is represented by the few analysed cases; also, from the short-term follow-up. However, it is a problem of several authors, that often have reported favorable results at short-term follow-up after ACI treatment, but long-term data are lacking (17-22).

The absence of alterations in Arthro-CT in asymptomatic patient suggests that both the ACI technique and the scaffold implantation have determined a restitution ad integrum of the chondral damage.

The presence of a high-level chondral lesion in Arthro-CT, in symptomatic patient, indicates the failure of both the surgery techniques.

In conclusion, the CT Arthrography, for the elevate spatial and contrast resolution, is a very accurate exam in detecting irregularities in the chondral-inductor scaffold implantation, and in correlating the clinical presentation.

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