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Jorge Javier Del Vecchio
Fundación Favaloro

Nicolas Raimondi
Fundación Favaloro

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Osteochondral Lesions of the Talus Treatment With Fresh Frozen Allograft

Juan Manuel Yañez Arauz [a,*], Jorge Javier del Vecchio [b], Facundo Bilbao [c], Nicolas Raimondi [a,b]

[a] Austral Universitiy Hospital, Buenos Aires, Argentina
[b] Fundación Favaloro University Hospital, Buenos Aires, Argentina
[c] Italiano Hospital, Buenos Aires, Argentina

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ABSTRACT

Introduction: Symptomatic talar osteochondral lesions are about 50% refractory to conservative treatment requiring a surgical solution. In the case of large chronic lesions, the use of bone graft taken from tissue bank is an alternative that enables to fill the defect without causing donor site morbidity.
Material and Methods: Eight patients treated with talar osteochondral allograft in lesions greater than 20 mm in diameter were analyzed - 4 males and 4 females aging 39.5 years old on average. Evaluation was performed according to AOFAS scale and VAS as well as incorporation and continuation evaluations according to CT and MRI studies. A follow-up of 46.8 months on average was done.
Results: A 34.6-point improvement on average according to AOFAS. A 6.7-point pain improvement on average according to VAS. Incorporation in 100% of the cases. Two cases showed partial resorption and one case showed peri-graft lysis less than 30%. There was no collapse.
Conclusions: Fresh frozen osteochondral allografts are a viable alternative when treating large osteochondral lesions, thereby avoiding morbidity of autologous donor areas or arthrodesis procedures.

1. Introduction

The hyaline cartilage is characterized by being an avascular tissue without innervations or lymphatic circulation having little or no repair capacity which increases if the subchondral bone is also damaged.[1] It feeds from the synovial fluid and, compared to other connective tissues, it does not have direct contact with other cells.[2]

Osteochondral lesions of the talus are caused by multiple factors such as embolism, bone formation defects, endocrine factors, genetic predisposition, avascular necrosis, among others, but today the traumatic cause is the most accepted one being either a repeated microtraumatic one or produced by a generally indirect ankle trauma.

As regards injury location, Raikin[3] divided the talar dome into nine areas for its better therapeutic analysis and with the purpose of creating behavior patterns of the above mentioned injuries.

The treatment of these lesions still represents a challenge as a result of the poor intrinsic repair or regeneration capacity that the hyaline cartilage has. Some of the obstacles for its repair consist in the fact that it is a hypocellular tissue and that chondrocytes are 'trapped' in an extracellular matrix.[4]

According to Pedro L. Ripoll and Mariano de Prado[5] after an articular cartilage and subcondral bone injury, start a repairing response, which produces fibrocartilage. This is important to mention because the fibrocartilage does not have the same biomechanical characteristics as the hyaline cartilage and therefore it increases the friction.

Buckwalter *et al.* [6] mentions that the loss of proteoglycan content and the disruption of the collagen surface layers cause fibrillation and ruptures through the orientation of collagen fibers on deep layers.

Generally, choosing the treatment depends on local factors (injury area, size and chronicity), as well as on general factors (age, activity, comorbidities, bad alignment, among others).

Although a conservative treatment is the first choice and with certain effectiveness in approximately 50% of the skeletically mature people, the injury will continue being symptomatic and that is why surgery is indicated.

Broadly speaking, two surgical alternatives can be mentioned:[7]

* Corresponding author.

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1 Repairing techniques: osteochondral stimulation procedures, abrasion arthroplasty and Pridie's perforations are included.
2 Restoring techniques: osteochondral replacing procedures such as the implant of autologous chondrocytes culture and osteochondral mosaicoplasty with autograft or allograft.

Within the therapeutic options, arthroscopic debridement and microfractures are the procedures first chosen before opting for more invasive treatments such as osteochondral autotransplantation or mosaicoplasty, allotransplantation or autologous transplantation of cultured chondrocytes.

But in the case of injuries of large size and volume or located in the talar dome 'shoulder', these may not benefit from debridement and micro-perforation treatments or osteochondral talar graft transport since the morbidity created in the donor zone has a lower success rate.

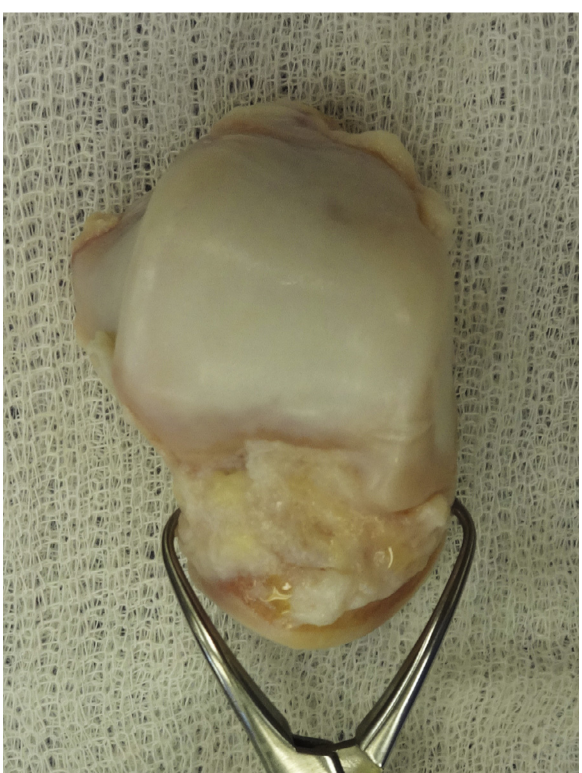
2. Purpose

The purpose of this study consists in evaluating the clinical and image-related results in the medium term of patients undergoing fresh frozen allogenic osteochondral transplantation suffering from talar chronic osteochondral injuries greater than 20 mm.

3. Materials and Methods

This is a retrospective analysis based on the clinical history of patients.

In the period between May 2004 and May 2010 10 patients with symptomatic and chronic talar osteochondral injuries were treated with surgery using non-irradiated fresh frozen allograft transplantation. Out of the total, only 8 patients could be followed up - the ones included in this study. One patient moved to another country. Another patient could not be reached for physical examination (they were only clinically and radiologically followed by 6 months, so they were not included in the study).



Picture 1.

All surgeries were performed by the same surgical team specialized in leg, ankle and foot surgery.

The study of injuries was carried out by tomographic measurement in the preoperative period with sagittal, coronal and axial cuts. Measurements were recorded in millimeters and their volumes were set in mm^3. The lesion chronicity was determined according to the time of evolution. More than 6 weeks was considered as a chronic injury. All injuries were chronic.

The injury was located in the talar dome according to Raikin's [3] topographic classification. Out of the total of the patients, 5 injuries were found in zone '4′', 1 injury in zone '5′', 1 injury in zone '6′' and 1 in zone '7′'.

Four patients were men and four were women. In 4 cases the talus in question was the right talus and in the remaining cases it was the left talus.

Three patients reported a history of indirect trauma whilst five patients did not recall any history of trauma.

The patients' average age was 39.5 years old ranging from 17 to 63.

Criteria to include patients in this study:

a) Talar osteochondral injuries free from surgeries.
b) Injuries greater than 20 mm in one of its axes.
c) Injuries treated with one-piece osteochondral talar allograft.
d) Follow-up longer than 18 months.
e) Pre- and post-operative evaluation with AOFAS and VAS scores.

3.1. Bone Graft Taken from Tissue Bank

The donor allograft was taken from the Tissue Bank of the Hospital where the study was carried out. Non-irradiated processed frozen cadaveric allografts were used in all cases (Picture 1). A serologic test, a profile of previous diseases and of the social context were conducted. Per each segment five samples were taken for culture.

The processing consisted in taking soft parts, removing the fat, hemolyzing the segment, washing, cutting upon demand, taking 5 samples of soft parts and bone, culturing water for washing, wrapping the samples three times with 90- and 200-micron laminated nylon, waiting for the final culture, and its pertinent definite storage at -86 °C.

The average time elapsed from the moment the graft was obtained to its implantation was 4.5 months. Anatomical parts were evaluated with CT and the matching with the receptor talus could not be greater than 1 mm.

3.2. Clinical and Image-related Evaluation and Surgery

The surface of all injuries was more than 20 mm in some axes. The average injured volume was 2674 mm^3.

Six patients required a malleolar osteotomy to provide adequate access (Picture 2). An anterior tibial osteotomy was conducted in 1 patient (Picture 3) and the other patient had a lateral pre-malleolus approach without the need of an osteotomy.

The graft was carved after preparing the receptor zone according to its size and shape (Picture 4) and a single osteocartilagenous block was grafted (Picture 5). The allograft was stabilized by means of a metallic pin in 1 case and by biodegradable pin in 5 cases (Picture 6) and in the remaining 2 patients the allograft was not stabilized.

In the cases of tibial osteotomy, the final synthesis was carried out by 4.0 screws of partial thread.

All patients were clinically evaluated according to the AOFAS[8] score for ankle and hindfoot (Table 1) and according to the visual

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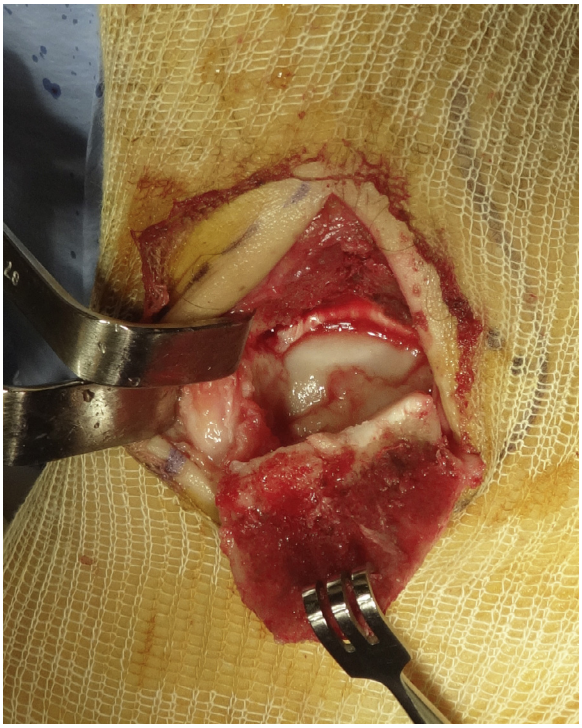
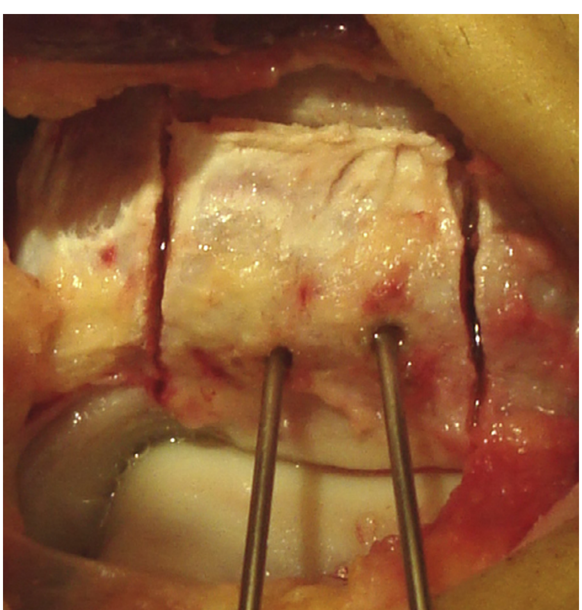


Picture 2.

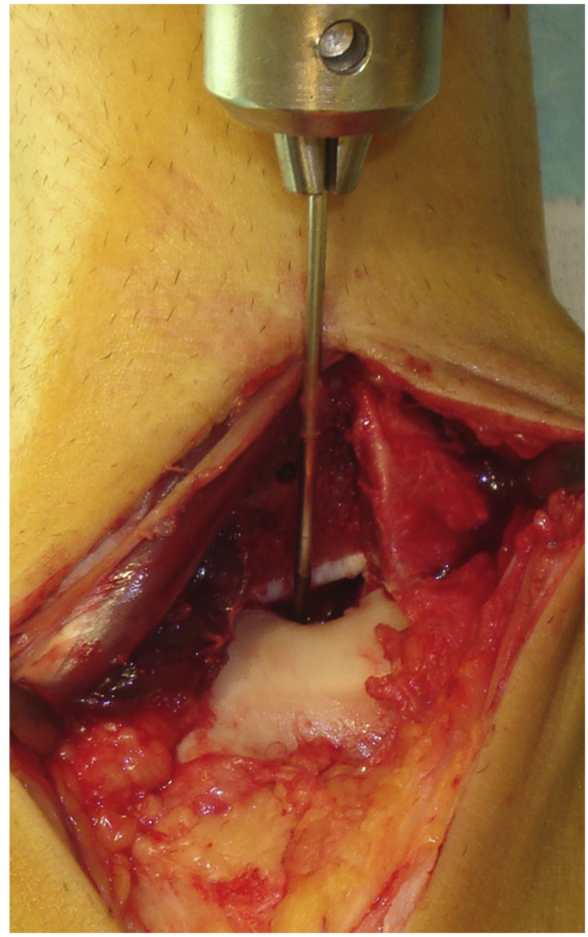
analog pain scale both in the pre-operative period and the follow-up period in a medium or long term.

The allograft incorporation, its collapse and/or resorption and the presence of perigraft lytic areas were analyzed in the post-operative period by means of image studies (X-ray and CT scans). The continuity and thickness of the graft articular cartilage was evaluated by means of magnetic resonance. All image-related studies analyzed in the post-operative period were conducted more than 18 months after the surgery.

The minimum follow-up was 18 months and the maximum one was 90 months with an average of 46.8 months.



Picture 3.



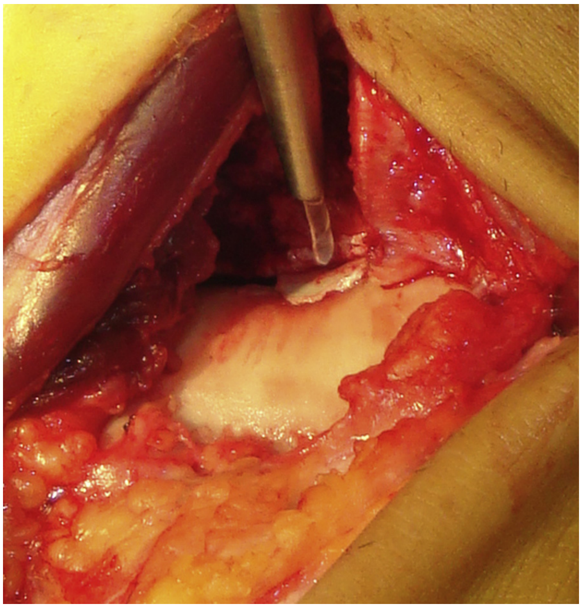
Picture 4.

4. Results

4.1. Clinical-Functional Evaluation

The average of the AOFAS scale in the pre-operative period was 59 points ranging from 28 to 67 points while in the post-operative period was 93.6 points ranging from 87 to 100 points. (Chart 1).

Picture 5.



Picture 6.

The average improvement according to the AOFAS score between the pre- and post-operative period was 34.6 points.

Regarding the visual analog scale to analyze pain, the average value obtained before the surgery was 7 (ranging from 6 to 10 points) and after the surgery it was 0.25 (ranging from 1 to 0).

On average, the pain improved 6.7 points according to the VAS rating system.

4.2. CT scans Evaluation

Graft incorporation was observed in all patients (Picture 7).

In 2 cases (25%) the partial graft resorption was objectified measured as percentage according to the size of the original graft.

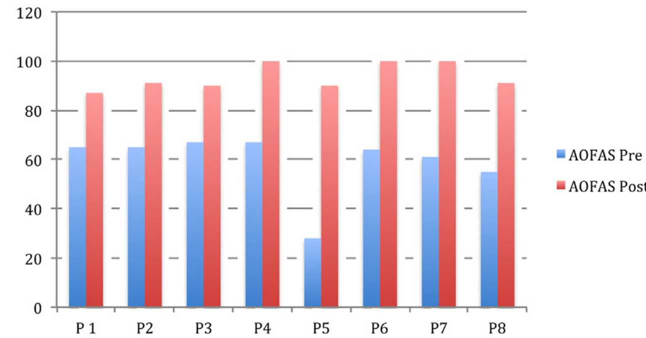


Chart 1. Pre- and Post-operative AOFAS scale of the 8 cases

In one patient, the resorption was 30% and in the other patient it was 10%. In both cases graft resorption was subchondral (Picture 8).

Perigraft reactive bone lysis was evidenced in one case occupying 30% of its circumference remaining the graft in its original shape.

Graft collapse was not observed in any of the cases.

4.3. Magnetic Resonance Evaluation

Thickness of the preserved graft was objectified in all patients compared to the original graft (Picture 9).

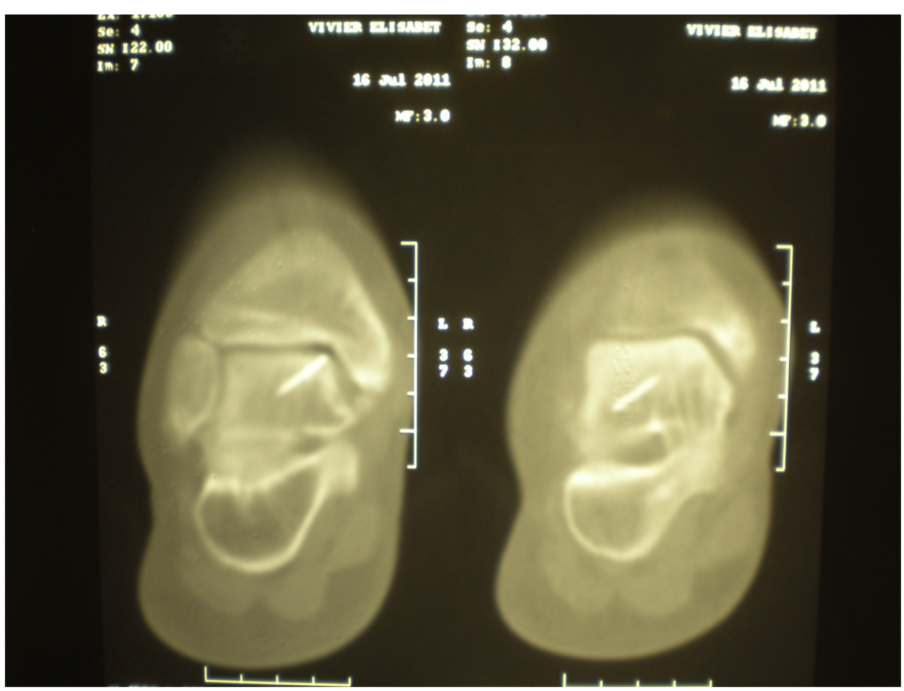
Cartilage discontinuity of the allograft was observed in only one patient compared to the receptor talar cartilage. In this case was not graft resorption.

4.4. Complications

No complication associated with the surgery was observed during the follow-up period.

In only one patient the osteosynthesis of the osteotomized tibial malleolus had to be removed due to pains in the area.

Neither of the patients needed revision of the talar surgery.



Picture 7.

Picture 8.

Picture 9.

5. Discussion

Hyaline cartilage injury has little repair capacity by itself. [9]

Treatment by means of multiple micro-fractures tries to injure the subchondral bone to make fibroblasts enter and generate a fibrocartilaginous repair. Literature describes that 75% of the cases had good results after 3 years reducing the pain significantly. Studies [10,11] mention that survival of the neo-fibro-cartilage reaches 95% after 4 years and 92% after 7 years in non-massive injuries.

There is no ideal method to repair hyaline cartilage injuries [11–13] since there are diverse types of injuries as regards shape, location, size, among others.

Many surgical techniques have been described to treat symptomatic osteochondral injuries and many of them are used in injuries with less than 1.7 cm^2 and volumes lower than 2 cm^3. In general, more serious injuries would not be subject to autotransplantation of ipsilateral knee or to chondrocyte transplantation. Talar transplantation of injuries greater than 3 cm^3 would represent more complications in the donor zone.

For these cases of great defects, osteochondral allografts have an advantage since they allow for filling of injuries of diverse sizes and shapes without morbidity in other donor areas of the patient's economy.

It is described that residual viable chondrocytes are observed years after the osteochondral allogenic transplantation of tissue bank. The fresh grafts offer the greatest viability of chondrocytes.[14] Within the fresh grafts, fresh frozen grafts showed a lower rate of transmissible diseases compared to fresh but non-frozen grafts. [15]

Osteochondral allografts were used for many years in tumor reconstructions and for distal femur massive defects. [15,17] Gross *et al.* [18] reported 9 patients who were treated with osteochondral fresh allograft in ankle injuries greater than 1 cm in diameter and 0.5 cm in depth. After a twelve-year follow-up 6 out of 9 grafts were still in one piece while 3 patients needed ankle arthrodesis.

Frozen osteochondral transplantations are easily incorporated by the host; however, while the hyaline cartilage survives to the transplantation, the number of viable chondrocytes in cryopreserved transplantations is lower compared to fresh transplantations. [4,14]

Williams *et al.* [14] have published in their study that the transplanted cells of a frozen transplanted tissue survived 50 to 70%; this accounts for a lower percentage than the survival rate of the fresh cell transplantation (95 to 99%). Therefore, fresh allografts have better potential capacity to be incorporated to the receptor site since they have greater chondrocyte viability.

Despite the above mentioned, fresh frozen grafts showed - in an experimental way in a pork model–viability statistically comparable to fresh grafts. [19] Although the frozen allograft may not be as ideal as the autograft or fresh allograft, the low morbidity and the availability of the fresh frozen tissue turns it into an acceptable alternative when treating large lesions. There is no clear scientific evidence that defines an advantage of fresh allografts over frozen ones although empiric data favor the former ones.

According to the study carried out by Suyimoto *et al.* [20], the thickness of the hyaline cartilage of the talus varies depending on sex and the location in the talar surface; an average of 1.35 mm + - 0.22 mm in men and 1.11 mm + - 0.28 mm in women is considered. The cartilage exact value in mm could not be determined in this study so the correspondence of the donor cartilage with the receptor one was studied as well as how the thickness of the grafted cartilage similar to the immediate postoperative one was maintained.

El Rashidy *et al.* [21] carried out a retrospective study of the talar fresh allograft outcomes objectifying an increase of 26.5 points according to the AOFAS score and 6.7 points according to the VAS rating system on average. This study, in which fresh frozen allograft was used, showed an increase of 34.6 points according to the AOFAS score and of 6.7 points according to the VAS rating system on average.

Publications of Raikin *et al.* [22] and Adams *et al.* [23] mentioning the use of fresh allograft to treat osteochondral lesions of the talus describe the same use in injuries between 6059 mm^3 on average the former study and 2089 mm^3 on average the latter study. In the first case, the follow-up was 44 months and in the second case, it was 48 months on average. The pain improvement was of 5 points according to the visual analog scale in both studies. In this study, the average of injury volume was 2674 mm^3. Results can be compared to an average follow-up of 46.8 months and a pain improvement of 6.7 points according to the VAS score.

Hahn *et al.* [24] published the outcomes of using fresh allografts in osteochondral lesions of the talus in 13 patients ageing 30 years old on average during a mean follow-up of 48 months. They found a 36-point improvement according to the AOFAS score and their patients were completely satisfied. These data are similar to the ones found in this study in which 8 patients ageing 39.5 on average were evaluated. The mean follow-up was 46.8 months and the pain improvement according to the AOFAS score was of 34.6 points.

Within the limitations found in this study the following can be mentioned:

1 The low number of evaluated cases although we have not found international bibliography and publications mentioning numerous series. Neither have we found national publications on this matter.
2 Follow-up is performed in a medium term and not in a long term.
3 It is a retrospective study.
4 It does not have a comparative control group.

6. Conclusions

Despite the low number of cases, the clinical-functional results when using fresh frozen allograft were satisfactory in a medium term (AOFAS 94/100 on average).

The fresh frozen osteochondral graft taken from a tissue bank offers a structural contribution. It is important to carry out a comparative tomographic study of the receptor talus and of the one taken from the bank.

After having studied the series it can be said that fresh frozen osteochondral grafts are a valid alternative when treating large osteochondral injuries, thereby avoiding morbidity of autologous donor areas or arthrodesis rocedures.

The allograft procedure does not invalidate the possibility of using other reconstructive procedures or else prosthesis articular replacement or arthrodesis procedures.

Conflicts of Interest

None

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