Many studies have shown that satisfactory outcomes can by seen if calcaneal intraarticular fractures are treated with modern methods of reduction and osteosynthesis. However, 2-17% of cases undergo secondary fusion due to the development of painful subtalar traumatic osteoarthritis. The development of this complication is directly related to the degree of comminution of the calcaneal facet of the posterior subtalar joint, with or without a heel.

Artrodesis subastragalina primaria en trabajadores con fractura del calcáneo

Introduction. Se presenta la evaluación retrospectiva de 6 casos de fracturas intraarticulares conminutas del calcáneo tratadas con reducción abierta, reconstrucción de la forma del calcáneo, injerto óseo autólogo y artrodesis subastragalina primaria fijada con un tornillo canulado de 7 mm, en el período comprendido entre noviembre de 1997 y agosto de 2002.

Material y método. Todos los pacientes eran trabajadores cubiertos por el sistema argentino de riesgos laborales. La decisión para tal técnica fue tomada preoperatoriamente en tres casos de fracturas tipo IV de Sanders mediante la evaluación de cortes tomográficos coronales, e intraoperatoriamente en tres casos de fracturas tipo III de Sanders cuando, bajo visión directa, se constató compromiso del cartílago articular que afectaba al tercio o más de la carilla calcánea posterointerna.

Resultados y conclusiones. Todas las artrodesis consolidaron dentro de los primeros 4 meses de tratamiento. La dehiscencia de la herida con necrosis angular del colgajo dorsal del abordaje fue la principal complicación (50% de los casos). No se observó artritis de articulaciones vecinas. Los pacientes retornaron a sus anteriores empleos antes de los 6 meses de evolución. El seguimiento promedio fue de casi 30 meses. La puntuación promedio según la American Orthopaedic Foot & Ankle Society (AOFAS) fue de 76 puntos.

Palabras clave: fractura, calcáneo, artrodesis subastragalina, trabajadores.

Key words: fracture, calcaneum, subtalar arthrodesis, workers.

Many studies have shown that satisfactory outcomes can be seen if calcaneal intraarticular fractures are treated with modern methods of reduction and osteosynthesis. However, 2-17% of cases undergo secondary fusion due to the development of painful subtalar traumatic osteoarthritis. The development of this complication is directly related to the degree of comminution of the calcaneal facet of the posterior subtalar joint, with or without a heel.
 MATERIALS AND METHODS

From November 1997 to August 2002, 36 patients with intraarticular calcaneal fractures were seen. They were all cases of accidents at work and were covered by work accident insurance according to Argentine Law 24.557.

Thirty-one patients underwent surgical treatment, of which 6 underwent a primary subtalar arthrodesis. All patients signed an informed consent form for surgery. All the patients were men. Mean age was 38 years (range: 23-60), 4 of whom had extensive edema and bruising and 3 that had anterior lesions had serous or blood blisters.

The causes of trauma were falls from a height in 5 cases (in the work-place) a motorcycle accident (on the road to work); three patients were construction workers, one a farm-hand, one an elevator repairman and one a bus driver.

Two patients had significant associated lesions: one had a Gustilo I open fracture of the contralateral calcaneal and type A2 vertebral fractures at L1, L2 and L3, and other had a neurovascular injury (in the work-place) a motorcycle accident (on the road to work); three patients were construction workers, one a farm-hand, one an elevator repairman and one a bus driver.

In all cases it was necessary to fill in the remaining bone defects with bone graft taken from the iliac crest. 4 patients received a cancellous graft and 2 patients received a complete thickness graft (tricortical). As to the bone graft, we always used an iliac crest autologous graft since it is better as far as osteointegration, osteoinduction and osteo...
conduction in comparison with bone substitutes. We have not had any problems using this type of graft.

Arthrodesis fixation was carried out by means of a 7 mm partially threaded cannulated screw, placed using moderate compression to prevent excessive valgus displacement of the calcaneus. In 3 cases it was placed from the talus towards the calcaneus and in the remaining 3 from the calcaneus towards the talus using separate mini-incisions.

Closure of the approach was especially important. Once the hemostatic cuff was released, we made sure that the proximal flap had a good blood supply and carried out extensive hemostasis. Aspiration drainage was placed in all cases. Separate or Donati sutures were placed, without tension. To better control postoperative pain, anesthetic block of the incision was performed. Initial postoperative immobilization was achieved with a one half well-lined spica cast for 2 weeks, to allow regular wound inspection. Subsequently a short non-weightbearing spica boot was used from 8 to 10 weeks, according to each case. Subsequently weightbearing was allowed with a walking heel until 12 to 14 weeks post-operatively according to the degree of comminution.

Lastly, once the spica cast was removed, a rehabilitation program was carried out until the patient was discharged. Each patient was regularly controlled clinically and by X-rays (Figure 1).

Mean follow-up was 29.66 months, from the moment of hospital discharge (range 13-47 months).

**Figure 1.** Forty-three year old male, bus driver, with a type IIIAC right calcaneal fracture, with significant destruction of the posterior facet (A). There were haemorrhagic blisters, extensive bruises of the ankle and foot (B). Clinical and X-ray results at 3 years after surgery (C), (D) and (E).
RESULTS

In all cases there was complete arthrodesis healing by 12 weeks after surgery. On average, healing was complete at 13 weeks (range 12-15 weeks). Patient discharge was on average at 23 weeks (range 20-30 weeks).

The most significant postoperative complication was wound dehiscence with necrosis of the angle of the upper flap in 3 cases (50%). Two patients had suffered a type IV fracture and both were smokers, the third patient had a type III fracture (Figure 2). In all cases this was resolved with local damp dressings and antibiotics (rifampicin) until complete closure of the lesion. In one case there was healing at 10° valgus, with no specific symptoms. In another case, the osteosynthesis material, that had been placed from the talus, had to be removed due to local intolerance.

The calcaneus was reconstructed to achieve 90% of its original shape, comparing it with the normal side. In the bilateral case in which a secondary subtalar arthrodesis was performed in the contralateral calcaneus, the primary arthrodesis was the best way to achieve shape reconstruction.

No degenerative lesions were seen on X-ray in neighboring joints (ankle, calcaneo-cuboid or talar-navicular) in any of the 6 cases.

Results in general were good, and all patients returned to work after discharge at 23 weeks on average. Two had to be professionally re-qualified, although they continued to work for the same firms; the remaining 4 returned to the work they had previous to the accident. From the point of view of work disability, the patients had 6.6% disability (range 4.80-13.67%). A highly satisfactory value, if we keep in mind that the Argentine Scale for Work Disability considers values of up to 30% disability for calcaneal fracture.

Finally, using the assessment table of the American Orthopaedic Foot & Ankle Society (AOFAS) the average was 76 points (range 68-85).

DISCUSSION

Severe intraarticular calcaneal fractures (Sanders types III and IV) are significant lesions, caused by high energy trauma such as falls from heights or traffic accidents, they usually affect active workers that carry out physically demanding activities. The usual protocols for treatment of these fractures include non-surgical functional treatment or open reduction and internal fixation with or without bone grafts. Many fractures treated in any of these ways require salvage secondary subtalar arthrodesis due to the pain caused by post-traumatic osteoarthritis[1-5,8-11].

If the initial treatment chosen is not surgical, it is much more difficult to achieve this fusion, since it is necessary to re-shape the calcaneus, making sure it has an adequate height, length and width, before fixating. This is very important since maintaining normal relationships between the calcaneus, the talar, the cuboid and the navicular ensures the complex movements of the rearfoot. Moreover the soft tissues shorten and retract and there may be postoperative complications related to skin coverage[6].

If the initial treatment chosen is open reduction and internal fixation, arthrodesis in a second operation is performed on structures close to anatomic normality, but treatment is prolonged, delaying return to normal activities and work. On the other hand, if the time between fracture and arthrodesis is too prolonged, it is more difficult to achieve fusion, to such an extent that many authors have had unsatisfactory results with secondary arthrodesis[6,12,13].

We use Sanders’ classification as an orientation on the treatment to apply. In fractures type I, II and IV we agree with Sanders as to the treatment to apply: in type I non-surgical treatment, in type II open reduction and internal fixation, in type IV primary arthrodesis. In type III, as in type II, Sanders advises open reduction and internal fixation, we do not agree on this, although at the beginning we approached type III fractures with the idea of carrying out osteosynthesis, the factor that determines the treatment to be applied, in our opinion, is the degree of integrity of the pos-
tero-external facet joint. If we see that the comminution of the joint surface is greater than one third we carry out primary arthrodesis.

It is evident that anatomical reduction with reconstruction of the calcaneal, bone graft and primary subtalar arthrodesis with internal fixation in one operation, may limit the morbidity associated with this fracture. However, it must be remembered that it is a technically demanding procedure, and, sometimes, the decision to carry it out is made intraoperatively. Moreover it does have complications. In our experience, we saw difficulties and complications related to skin covering, inspection of the joint facet and internal fixation.

With reference to skin coverage, we saw problems with wound closure, since in 50% of cases there was dehiscence and skin sloughing at the angle of the incision. We consider that this is due to the pronounced deformation of the heel caused by widening that changes the anatomy, this may affect the correct positioning of the incision.

On the other hand, it must be remembered that these fractures are caused by high energy trauma, with the consequent initial combined damage of bony and soft tissues.

As many other authors have seen, we believe that the delay to surgery and smoking are risk factors for soft tissue necrosis6,10.

Inspection of the postero-external joint facet is carried out visually and radioscopically. Since this facet has an irregular shape and Broden views and low resolution image intensifiers provide unreliable information, this inspection may become difficult (especially in the case of the internal sector of the facet) and results may be under or overvalued.

Open arthroscopic inspection has also been assessed and this allows a correct assessment of the state of the total extension of the joint surface6,11.

We performed internal fixation of the arthrodesis in 50% of the cases with a 7 mm cannulated screw from the calcaneus to the talus and in the other 50% from the talus to the calcaneus, indifferently. However, using this last procedure in one case we had to remove the screw due to discomfort on dorsal flexion of the ankle. Currently we prefer to use the technique from the calcaneus to the talus, since it is easier, faster, usually the head of the screw can be buried in the calcaneus without causing subsequent problems and there is no risk of affecting the circulation of the talus10.

Subtalar arthrodesis is not a new procedure. The zenith of its success was from 1930-1960 when the techniques of Gallie12 and Harris13 became popular, even in trauma surgery circles in Argentina11,14. When Lindsay and Dewar in 1958 made it known that many arthrodesis had been unnecessary and that the final outcome mainly depended on the initial deformation, no matter what treatment was used, this technique was abandoned as a first choice, and became a salvage procedure14. Since the work of Sanders et al in 1993, several authors have established the superiority of primary subtalar arthrodesis in the treatment of selected comminuted fractures15-18,19,20.

This last issue has been assessed by comparison of results of primary and secondary subtalar arthrodesis. Huefner et al10 assessed 17 patients with secondary arthrodesis and saw an AOFAS score of 69 on average, whereas in primary arthrodesis the AOFAS score was 88 on average. In our series we obtained an AOFAS score of 76 on average, lower than the last one mentioned but higher than that seen by Flemister et al20 who had an AOFAS score of 75.4 on average and Bach et al10 who had 72.4.

For us, as trauma surgeons who treat workers, the time elapsed before a worker with a calcaneal fracture can return to work and their condition when they do return to work are extremely important21. We consider the results we obtained very satisfactory as all the patients returned to their work in less than 6 months while in most series this is achieved in 6-9 months.

In conclusion, our experience with this series of cases has shown that primary subtalar arthrodesis with reconstruction of the calcaneus is a satisfactory procedure for Sanders type IV fractures based on a preoperative decision made on analysis of the CAT image; and for type III fractures based on an intraoperative decision, if the intra-articular damage affects more than one third of the surface of the calcaneal facet. The outcomes seen in these 6 cases were encouraging, since complete healing was achieved in all cases with good functional results and return to work before 6 months on average. However 50% of the patients had postoperative complications of the wound with angular necrosis; although all resolved satisfactorily, it is necessary to underline, in as far as local tissue deformation allows, the need to make the incision on the correct approach line, which is precisely on the limit of two vascular structures.

REFERENCES

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