Clinical Outcome of Reconstruction Surgery for Malunited Calcaneal Fracture without Subtalar Arthodesis – A Prospective Study

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Abstract

Calcaneal fracture is the most common fracture in the tarsal bones. Treatment is difficult because the patterns of fracture are various and complications occur frequently. The purpose of this study was to evaluate the clinical results of calcaneal reconstruction for chronic complications after calcaneal fracture.21 patients with malunited calcaneal fractures treated in our hospital from 2014 to 2016 with reconstruction surgery without subtalal arthodesis. The functional outcome was asessd by AOFAS(American association of orthopaedics foot and ankle society) hind foot and ankle score.Out of 21 patients 19 were male and 2 female with an average age 32.7 yr. Average time period from injury to reconstructive operation was 11.2 month. Time of union ranging from 10.8 to12.7 month (average 11.33).Pre operative AOFAS score 43.5and postoperative score was 79.7. Bohler angle, Gissanes angle, Talo calcaneal angle and calcaneal width were checked pre and postoperatively shows a very good result. The management of calcaneal fractures will continue to pose significant challenges to the orthopaedic surgeon *due to complexities of fracture patterns and the existing limitation of soft tissue envelope. Reconstruction of calcaneum by ORIF(open reduction and internal fixation) without subtalar arthodesis shows good results in terms of clinical and functional outcome of the patients in a intermediate term follow up.*

Keywords: *Calcaneum, AOFAS SCORE, Bohler angle, Gissane angle, ORIF.*

I. INTRODUCTION

Fracture of the calcaneum remains among the most challenging for the orthopaedic surgeon accounts for approximately 2% of all fractures, with displaced intraaticulars fracture comprising 60 to75% of these injury.[1] Nonoperative treatment of displaced calcaneal fractures, as well as inadequate reduction or failed surgery, may result in painful malunion with severe functional deficits that may and a decrease of ankle dorsiflexion, whereas malalignment may result in varus or valgus deformity of the calcaneus. Subfibular tendinopathy and peronial tendon impringment lead to pain and instability.[2] Abnormal function of the ankle, subtalar, and transverse tarsal joints can lead to pain and disability in a large number of patients. The afffected patients experience difficulty in putting on their shoes and walk with a limping gait.

Depending on the type of deformity, many authors have advocated different reconstructive strategies.Stephens and Sanders developed a treatment algorithm based on CT scan classification of calcaneal malunion as well as a treatment protocol for this.[3] The classification system divided the calcaneal malunions into 3 categories: a type I malunion includes a lateral wall exostosis only, a type II malunion has lateral wall exostosis and subtalar arthritis, and a type III malunion has lateral wall exostosis, subtalar arthritis, and angular deformity. The core step of these protocols is reconstruction of the normal calcaneal morphology and subtalar arthrodesis. . The symptoms of posttraumatic arthritis were alleviated through subtalar fusion. However, the talonavicular joint greatly influenced the overall hindfoot function.It also plays an important role in adduction and abduction of the hindfoot. After subtalar fusion, the foot maintained only about 50% of its transverse tarsal motion compared with the contralateral side.The subtalar joint also pronates and supinates during the gait cycle, which is essential for adapting to ground surface and structural abnormalities.

A cadaver study by Savory et al showed that the motion of talonavicular joint decreased significantly after subtalar arthrodesis, including a 56% decrease in dorsiflexion and plantar flexion and a 70% decrease in inversion and eversion.[4] Therefore, the ideal procedure to treat calcaneal malunion should not only correct the deformities but also preserve the motion and congruence of the subtalar joint. We have found patients with malunited calcaneus fractures who still have normal articular cartilage in the subtalar joint. After the congruence of the subtalar joint is restored and the deformity is realigned, the symptoms caused by subtalar osteoarthritis can be greatly alleviated and a

functional subtalar joint can be preserved. The purpose of this study was to report the short- to intermediate-term clinical and radiographic outcomes of this method.

II. MATERIAL AND METHOD

From august 2014 to November 2016, 67 calcaneal malunions in 49 patients were surgically treated in our department. According to preoperative evaluation and intraoperative direct visualization, 21 patients met the criteria and underwent reconstructive subtalar surgeries in this prospective study .The rest of the patients excluded from the current study underwent reconstructive osteotomy with subtalar arthrodesis or other surgical procedures.

A. Inclusion Criteria:

(1)The patient failed conservative treatment
(2) The primary fracture was type I,II,or III according to Sanders malunion classification (type IV fractures were excluded)
(3) The patient had calcaneal malunions with mild to no osteoarthritis
4) The articular cartilage of the calcaneal posterior facet was near normal by radiographs, CT, and intraoperative visual examination.

B. Exclusion Criteria:

1)Moderate to severe subtalal arthritis.
2)Pt having peripheral vascular disease and DM.

There were 19 males and 2 females with an average age of 32.7 years (range, 20·52 years) in this group. All patients had been initially managed at other hospitals, including 19 treated conservatively and 2 surgically (closed reduction and Steinmann pin fixation)..The average period from injury to reconstructive operation was 11.2 months (3-24 months). All patients had pain, walking disability, loss of the longitudinal arch, and anterior tibiotalar impingement as their main complaints. Twenty one patients underwent the reconstructive surgeries,including 16 feet with iliac crest autograft and 5 feet with the excised lateral exostosis. In this series,14 feet had a tongue osteotomy.Twenty one follow-up assessments were carried out at 1 year and 11/ 2 years post operation. Preoperatively, radiographs including lateral and axial views of the calcaneus and mortise view of ankle joint as well as CT scans with 3D reconstructions were taken to evaluate the deformities .

C. Surgical Technique

Under all availavle aseptic measure and spinal anasthetia, the patient is placed in the lateral decubitus position on a beanbag standard lateral extensile approach to the calcaneus is used. After rebuilding the calcaneal morphology, a proper size calcaneal locking plate was placed on the lateral wall.The elevated posterior facet fragment should be fixed by 2 or 3 cortical screws. Several cortical lag screws (3.5 mm) were inserted into the sustentacular fragment to maintain the reduction of the posterior facet.In most cases, all screws were placed through the plate holes to keep the fragments stable. Screws can also be placed outside the plate if necessary.C arm fluoroscopy was used to determine the proper reduction and screw placement. Care was taken to avoid varus or notable valgus of the calcaneus on the axial view.
The wound was closed in 2 layers with interrupted subcutaneous and skin sutures over a suction drain,which was placed so that it exited at the proximal tip of the vertical limb of the incision.

D. Postoperative Management

Range of motion andstreng thening exercise of ankle are begun 2 to 3 days after surgery. Weight bearing was delayed for 10 to 12 weeks,until fracture healing was confirmed by radiological evaluation . Patients were reviewed at 6 weeks,3 months,6 months,1 year, and 11/2 years after operation,with clinical and radiographic assessment of the progress of healing and complications. The motion of the subtalar joint was assessed by physical examination. The operated foot was evaluated with the American Orthopaedic Foot & Ankle Society (AOFAS) ankle and hindfoot score before the operation and at 1 year and 11/2 years after the operation.

III. RESULT

The average time to union was 11.3 weeks (10.8·12.7 weeks). Partial weight bearing was started at 8 weeks postoperatively, whereas full weight bearing was started at an average of 12.2 weeks (11·14.0 weeks). At 1 year of follow up, 5 (23.8%) patients had moderate pain and 8(38.1%) patients had mild pain occasionally; most of the pain was on the lateral aspect of the ankle .Six (28.6%) patients still had partial loss of subtalar joint motion; 5 of them believed that it did not interfere with their daily activities. At11/ 2 years of follow up, only 3(14.3%) patients still had moderate pain, and 6 (28.6%) patients had mild pain occasionally. Three (14.3%) patients still had partial restriction of motion, but none of them believed that it interfered with their daily activities. Seventeen (80%) patients were satisfied with the results and returned to their preinjury work and activities, 2 (9%) patients had changed their occupation and worked part time, and 1 had not resume work. Eighteen (85.7%) patients had a stable hindfoot subjectively and clinically. Two (9.5%) patients had a slight limp when walking. One patient had ongoing hindfoot pain and restricted movement and underwent subtalar arthrodesis at 2 years after our reconstructive operation. Eighteen (85.7%) patients had no discomfort or stiffness when passively exercising the

subtalar joint, whereas 2 patients (9.5%) felt stiff and 1 patient (4.8%) felt stiff with pain. Stephens and Sanders types I, II, and III calcaneal malunions were observed in 3, 14, and 4 patients preoperatively, respectively, and in 9, 12, and 0 patients postoperatively, respectively, which suggests a statistically significant improvement (*P*=.0154)

Table I : Comparision of Pre and Post op Stephens and Sanders Type:

Pre op stephens and sander type	Post op			
	I	II	III	
I	3	0	0	3(14.28%)
II	5	9	0	14(66.66%)
III	1	3	0	4(19.04%)
Total	9(42.87)	12(57.13)	0(0)	21(100)

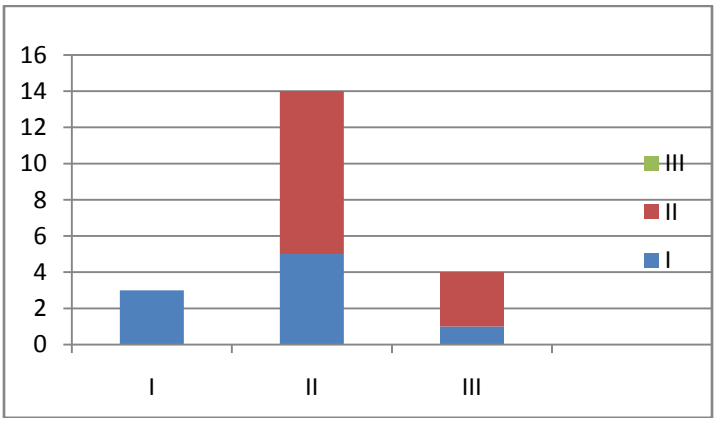

Fig. 1 (Graphic representation of pre and post op Stephens and Sanders types)

The average AOFAS score was 79.7points (62-92 points), whereas the average score preoperatively was 43.5points (32-62 points) . According to radiographs taken11/2 years postoperatively, the calcaneal morphology was much closer to anatomic status. The average Böhler's angle was 25.6 ± 4.7 degrees, the average Gissane's angle was 121.7 ± 4.3 degrees, average calcaneal width was 34.3#3.4 mm,and the average talo calcaneal angle19.6#8.0 degrees.The comparison of differences before and after operation in radiographic images is summarized in Table 3. There were significant differences between the 2 groups in Böhler's angle, Gissane's angle,talocalcaneal height,calcaneal width,[5].The morphologies of most feet were well restored and the patients could wear normal shoes eventually.

Table II: (Summary of Pre and Post Operative Radiographic dDta and P Value Determined by Paired t Test)

	Pre op Mean+SD	Post op1 $1/_2$yrMEAN+SD	P VALUE
Bohlers angle(degree)	7.0±3.4	25.6±4.7	‹.005
Gissane angle(dgree)	92.2±12.6	121.7±4.3	‹.05
Talocalcaneal angle(dgree)	15.5±6.0	19.6.6±8	‹.02
Calcaneal width(mm)	45.2±5.4	34.3±3.4	‹.05

Of the 6 patients with radiographic arthritis, 1 had mild pain and 1 had continuous pain.The remaining 4 were asymptomatic.Six patients had wound edge necrosis and 2 had a superficial infection.One patient required a subtalar fusion for subtalar arthritis at 2years after surgery.

Fig.2.Pre operative and post operative x ray of calcaneum

IV. DISCUSSION

Nonoperative treatment of calcaneal fractures may result in malunion,which may result in long lasting disability for most patients.Many authors have described salvage measures for this problem.

In 1908, Cotton and Wilson reported that following closed reduction of calcaneus fracture, they performed delayed treatments for malunion.

In 1935, Conn described the traumatic flatfoot with its associated pathology and championed the triple or double arthrodesis to correct the deformity.

BRALY etal(1985) performed a lateral wall exostectomy combined with peronial tenolysis as an alternative to subtalar arhodesis in pt with calcaneal malunion with lateral pain.they reported good results in 9 of 11 patient.[9]

Carr et al (1988)described a technique of restoring the height of the hindfoot by distraction of the subtalar joint with bone block arthrodesis. Several complications were associated with this procedure, including nonunion, superficial wound problem, broken

screws, and varus position.The current mainstream techniques for calcaneal malunions include lateral wall decompression, in situ subtalar arthrodesis, distraction bone block arthrodesis, corrective osteotomy and subtalar arthrodesis, and triple arthrodesis.[6]

Stephens and Sanders attempted to evaluate this through coronal images at the levels of the posterior facet on CT scan, which is one of the most commonly used methodologies for classifying calcaneal malunion. Clare et al reported the availability of Stephens and Sanders classification and described that intermediate to longterm results depend on classification through subjective satisfaction and radiologic assessment. Our study also used Stephens and Sanders classification for all patients, and all postoperative outcomes were statistically significantly improved.

Distraction bone block arthrodesis is indicated in patients such as Stephens type II malunions whereas for more severe deformity (Stephens type III), the subtalar joint can undergo arthrodesis with corrective calcaneal osteotomy. [11]The goal of these measures is correction of the deformity and relief of the pain by osteotomy and subtalar arthrodesis. However ,there were few reports about restoring subtalar congruency with reconstructive osteotomy when treating calcaneal malunions.

The Stephens and Sanders classification is simple and easy to use,but it does not cover all types of deformities.[3] Traumatic osteoarthritis in the subtalar joint correlates not only with the severity of the injury but also with the duration of time between primary injury and surgery.There are inconsistencies between patients'complaints and severity of traumatic osteoarthritis. For some types of fractures, the fracture line of the malunions after removal of the lateral wall exostosis can be clearly visualized if the time since fracture is less than 12 months and almost normal articular cartilage surface is found.The longest period of the cases in this study was 24 months.This patient presented an almost normal cartilage surface (Sanders type I fracture,Stephens Sanders type II malunion) on radiographs, and no sign of subtalar osteoarthritis was visualized during the operation..8]

Mann and Baumgarten reported a 50% loss of forefoot abduction and adduction after an isolated subtalar arthrodesis. Savory et al found that the range of motion of the talonavicular joint changes significantly after isolated subtalar joint arthrodesis. In their research, there was a 56% loss of dorsiflexion and plantar flexion at the sagittal plane and a 70% loss of eversion and inversion in the coronal plane.[10] The investigators were convinced that normal range of subtalar joint motion is essential to the talonavicular jt[7]

The most obvious benefit of this surgery is the salvage of subtalar joint instead of arthrodesis. Thus,the motion of subtalar joint is preserved to a great extent,which may reduce the stress on the adjacent hindfoot joints and reduce the later development of degenerative arthrosis in these joints.Our study included 18 feet (85.7%) that had no discomfort or stiffness when patients passively exercised the subtalar joint; only 2 (9.5%) felt rigid and 1 (4.8%) felt rigid with pain.

Gavlik et al considered corrections of the deformed Böhler's angle, Gissane's angle, heel width, and weight bearing axis of calcaneus as the criteria of an accurate reduction.If a calcaneal fracture malunion has mild osteoarthritis, unacceptable deformity still needs to be corrected by surgery.

The reduced posterior facet should be fixed and prevented from collapsing post operation by using a plate(low profile locking plate). There were no implant failures in this series. We believe that the best procedure to prevent implant failure is to correct the malunion with appropriate autogenous bone grafts, leaving no defects.

This technique has the risk of subtalar osteoarthritis in the long term, which may require an arthrodesis eventually. Melcher et al followed 16 patients with intra articular calcaneal fractures for more than 10 years. In no case was there indication of need for a secondary arthrodesis. Although most patients showed slowly progressing posttraumatic subtalar osteoarthritis on radiographs, the subjective results (pain, capacity to work, sports participation) at 10 years were clearly better than at 3 years after surgery. In our group, radiographs showed degeneration in 6 patients, but only 1 patient had pain and discomfort. Once the deformity of the calcaneus is corrected by reconstructive surgery, a supplementary subtalar arthrodesis would be much easier if necessary.

V. CONCLUSION

The management of calcaneal fracture will continue to pose significant to orthopaedics surgeon due to complexities of fracture pattern and extensive limitation in soft tissue envelope. The results of our study found that restoring the subtalar joint with reconstructive osteotomy and autogenous bone graft gave satisfactory outcomes and a low reoperation rate for selected patients. Through our surgeries, the morphology of the malunited calcaneus was well

restored with salvage of the subtalar joint. However, we still need long term follow up to evaluate the outcomes of this technique. According to the current study, we recommend restoring the subtalar joint with reconstructive osteotomy and autogenous bone graft in calcaneal fracture malunions with mild osteoarthritis instead of subtalar arthrodesis.

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