Treatment for displaced navicular body fractures

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Background
Fractures of the navicular are not common. To repair navicular fractures, it is important to have an understanding of the surrounding anatomy. The navicular is a boat-shaped bone located in the medial midfoot that has multiple articulations.

Objectives
This article reviews the diagnosis, classification, and surgical technique for fixation of displaced navicular body fractures.

Materials and methods
Ten patients with consecutive 10 displaced navicular body fractures were treated surgically between March 2010 and March 2013.

Results
The mean postoperative score according to the American Orthopedic Foot and Ankle Society score system was 90.2 (85–100).

Level of evidence
Case series: type IV.

Keywords:
fracture-dislocation, internal fixation, navicular, naviculocuneiform, reduction, talonavicular

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Introduction

The navicular plays an important role in maintaining the medial longitudinal arch of the foot [1,2].

Navicular fractures are often the result of high-energy injuries. Patients present with either immediate or delayed pain [3,4].

In multiply injured patients, navicular fractures are often overlooked. These injuries are often picked up on the secondary survey. Unconscious patients should be examined carefully for unusual swelling or crepitus. If suspected, foot radiographs are indicated [5].

Often, there is swelling and point tenderness. The split or stress fractures are as a rule not associated with any deformity. The higher-energy injuries are associated not only with marked soft-tissue trauma but also with other injuries to the foot, and deformity is more likely to be present [6].

Acute avulsion, tuberosity, and body fractures have been described. Sangeorzan and colleagues (Fig. 1 and Table 1) categorized navicular body fractures into three types as follows: type I is a coronal fracture with no dislocation, type II is a dorsolateral to plantomedial fracture with medial forefoot displacement, and type III is a comminuted fracture with lateral forefoot displacement and carries the worst prognosis. All navicular body fractures with 1 mm or more of displacement require open reduction and internal fixation [7].

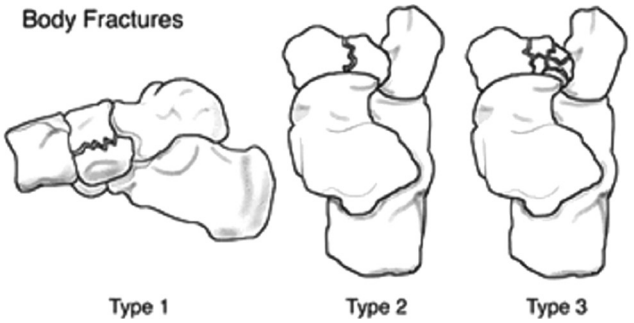
Rationale

This work focuses on displaced navicular body fractures and highlights the results of the surgical technique that was used to reduce this devastating fracture, leading to a prolonged recovery and significant long-term morbidity.

Table 1 Sangeorzan *et al.* [7] classification of navicular body fractures

Sangeorzan classification of navicular body fractures (on the basis of plane of fracture and degree of comminution)	
Type I	Transverse fracture in the sagittal plane of the dorsal fragment that involves<50% of bone (less comminuted). No associated deformity
Type II	Oblique fracture, usually from dorsal-lateral to plantar-medial.May have forefoot adduction deformity because of medial foot column shortening (most common type)
Type III	Central or lateral comminution.Abduction deformity (difficult reduction and worse prognosis)

Figure 1



Sangerozan *et al.* [7] classification for displaced navicular body fractures.

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Materials and methods

This was a prospective study of 10 patients with closed navicular body fractures; they were operated on at Benha University Hospital between March 2010 and March 2013. The mechanism of injury was a high-velocity injury in all patients. All the patients were men. The right side was affected in six patients, whereas the left side was affected in four patients. The mean age of the patients at the time of surgery was 28.6 years (range 17–40 years). There were no associated fractures. All patients were followed up over a follow-up period of 45.6 months (range 34–58 months). The time between trauma and surgery varied from 7 to 14 days, with an average 8 days.

Inclusion criteria

(1) Displacement or joint incongruity (>1 mm).
(2) Medial column shortening (>2–3 mm).
(3) Resultant subluxation or dislocation.
(4) Irreducible dislocations [8].

Exclusion criteria

(1) Open fracture or skin at risk.
(2) Other patterns of navicular fractures (i.e. tubercle, avulsion, stress fractures).
(3) Previous navicular pathology.
(4) A medical comorbidity disease that may prevent a surgical intervention such as diabetes associated with peripheral neuropathy, peripheral vascular occlusive disease, and immunocompromised patients.
(5) Smokers.

Operative technique

The goals of open reduction and internal fixation include anatomic reduction of the talonavicular joint, restoration of medial column length, and rigid fixation allowing for early range of motion [9].

The patient was positioned supine under general or regional anesthesia. A prophylactic antibiotic was administered. Pneumatic thigh tourniquet was inflated. Sterilization and draping were performed. The surgical approach should be based on a complete understanding of the fracture pattern and the associated injuries. The incision should be made in the longitudinal plane between the tibialis anterior and the posterior tendons with minimal dissection to prevent significant damage to the vascular supply. The goal in treating injuries involving the talonavicular joint is direct visualization of the articular surface to ensure an anatomic reduction. This is best achieved through a dorsal longitudinal incision over the area in question. Capsulotomies are used to expose both the talonavicular joint and the naviculocuneiform joints to facilitate judgment of the length and articular reduction of the navicular fracture. Extensive periosteal stripping over the dorsal navicular surface is unnecessary and this may disturb the tenuous blood supply to the central portion of the body. After the retraction of the anterior tibial tendon, minimal subperiosteal dissection of the fracture is performed. The fracture is evacuated of soft tissue and hematoma, and any cartilaginous or bone fragments are removed [10].

Large, sharp-pointed reduction clamps may be used to grip the major fracture fragments perpendicular to the fracture line, and the fracture is reduced by longitudinal traction. When treating fractures of the navicular, it is important to maintain the concavity of the navicular. Fluoroscopic guidance is used to determine the position of the screws. Fixation is provided by two 3.5 mm compression screws in a dorsal-to-plantar direction. During the approach, great care should be taken to avoid injury to the dorsalis pedis artery and the superficial and deep peroneal nerves, which invariably infringe on the operative field. A medial column spanning external fixator was applied not only to visualize the fractured fragments but also to maintain and protect the reduction [11].

Two Schanz pins 3 mm were used: one in the calcaneus and the other in the medial cuneiform. Using this spanning fixator, there was no need to harvest a bone graft to fill the defects. Closure was performed, followed by application of a crepe bandage.

In two cases, after capsolutomy of the naviculocuneiform joint, dislocation had occurred; thus, we used a 2.2 mm Kirschner-wire to maintain reduction of this dislocated joint.

Postoperative protocol

Postoperatively, the patient was confined to bed exercise with the foot elevated for 2 days. After 2 weeks, stitches were removed and ankle, hindfoot, and forefoot range of motion, both active and passive, were permitted. Until this period, the patient was advised absolute non weight bearing. The spanning fixator was removed after 6 weeks. Gradual and partial weight bearing was commenced. We routinely obtained radiographs to monitor fracture healing at 6–8 and 10–12 weeks.

Results

Results from open reduction and internal fixation of displaced body fractures of the navicular can be assessed using two methods.

Clinical

Clinical assessment was performed using the American Orthopedic Foot and Ankle Society (AOFAS) score

of the midfoot [12] (Table 2). The mean score was 90.4 (85–100). There was no a postoperative infection, and vascular or nerve complications. Sudek's atrophy occurred in three patients that was treated by hot fomentations, massage, and physiotherapy, without the need for medication. Superficial wound healing occurred in two patients who were treated by daily dressing and intravenous antibiotics (Figs 2–8 and Table 3).

Table 2 American Orthopedic Foot and Ankle Society midfoot score system [12]

Item	Degree
Pain (40 points)	
None	40
Mild, occasional	30
Moderate, daily	20
Severe, almost always present	0
Function (45 points)	
Activity limitations, support	
No limitations, no support	10
No limitation of daily activities, limitation of recreational activities, no support	7
Limited daily and recreational activities, cane	4
Severe limitation of daily and recreational activities, walker, crutches, wheelchair	0
Footwear requirements	
Fashionable, conventional shoes with no insert	5
Comfort footwear, shoe insert	3
Modified shoe or brace	0
Maximal walking distance and blocks	
Greater than 6	10
4–6	7
1–3	4
Less than 3	0
Walking surfaces	
No difficulty on any surface	10
Some difficulty on uneven terrain, stairs, inclines, ladders	5
Severe difficulty on uneven terrain, stairs, inclines, ladders	0
Gait abnormality	
None, slight	10
Obvious	5
Marked	0
Alignment (15 points)	
Good, plantigrade foot, midfoot aligned	15
Fair, plantigrade foot, some degree of midfoot malalignment observed, no symptoms	8
Poor, nonplantigrade foot, severe malalignment, symptoms	0

Radiological

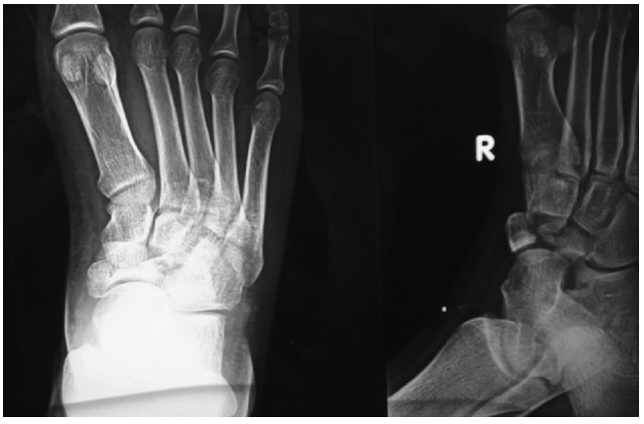
All patients were followed up. No bone graft was used. Union had been achieved in all patients, with a union rate of 100%. Union was confirmed radiologically after 6–10 weeks, with an average of 8.2 weeks. No postoperative talonavicular or naviculocuneiform arthrosis occurred that required a secondary arthrodesis. There was no avascular necrosis or hindfoot (varus) deformity.

Discussion

Injuries involving the midtarsal joint, particularly fracture dislocations, are extremely rare. They usually occur in young patients; thus, inadequate or poor treatment will lead to permanent disability and a huge economic burden [13].

It is important to understand the anatomy and the relationship of the navicular bone to appreciate its

Figure 2



Preoperative anteroposterior and oblique views of the right foot showed a type II displaced navicular body fracture.

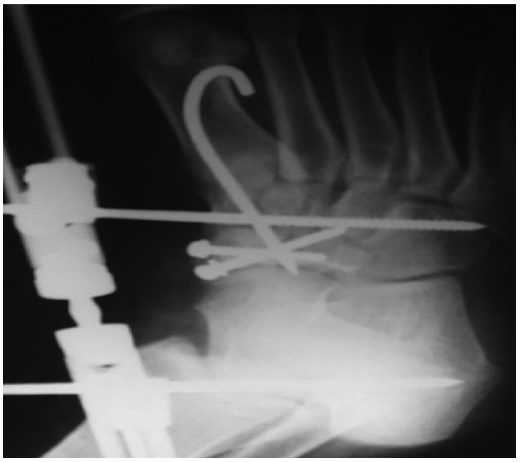
Table 3 Data summary

Number	Age	Affected side	Classification	Complications	Follow-up period (months)	Score
1	27	Left	Type II	Superficial wound infection	58	86
2	17	Left	Type I	No	54	100
3	22	Right	Type II	No	51	90
4	34	Right	Type III	Sudek's atrophy and superficial wound infection	49	85
5	28	Right	Type II	No	47	90
6	40	Left	Type II	Sudek's atrophy	44	88
7	27	Right	Type I	No	41	90
8	31	Right	Type II	Sudek's atrophy	4	90
9	33	Right	Type II	No	38	90
10	27	Left	Type II	No	34	95

Figure 3

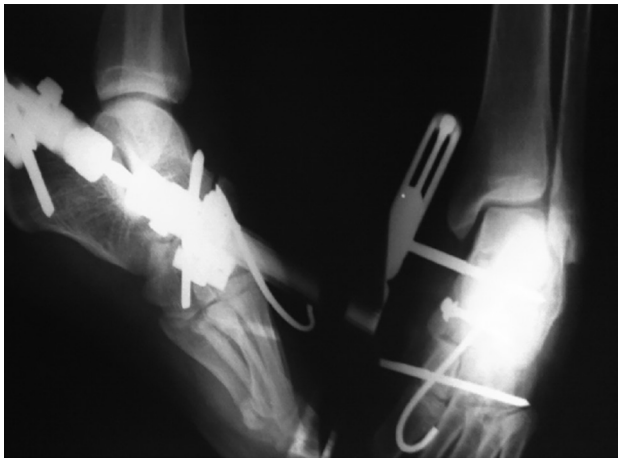
Preoperative sagittal computed tomographic scan.

Figure 4



Postoperative oblique view with a spanning medial fixator. A 2.2 mm Kirschner-wire was used to maintain reduction of the naviculocuneiform joint.

Figure 5



Postoperative anteroposterior and lateral ankle radiographic views.

Figure 6

Six weeks postoperatively, after fixator removal. Note: Sudek's atrophy.

Figure 7

One year postoperatively anteroposterior foot radiograph shows neither arthrosis nor avascular necrosis of the navicular.

Figure 8

Postoperative clinical picture of the right foot.

significance. It forms the medial longitudinal arch of the foot together with calcaneus, talus, and medial cuneiform [14,15].

These rare fractures are usually because of a forced planterflexion trauma, and most often occur without ligamentous injury [8].

This type of injury disrupts the normal arch of the foot. Open reduction and anatomical fixation of this fracture is mandatory as the tarsal navicular is the keystone of the medial longitudinal arch of the foot [7].

There are not many researches and studies on traumatic displaced body fractures. Sangeorzan and colleagues reported the largest series of patients with navicular body fractures. They reviewed 21 patients with displaced fractures of the navicular body and treated with open reduction and internal fixation. They noted radiographic evidence of healing at an average follow-up of 8.5 weeks. The average follow-up after surgery was 44 months, with a range of 12–106 months. There were four type I fractures, 12 type II fractures, and four type III fractures. Fracture of one patient did not fit any classification type. Overall results included 14 good, four fair, and three poor results. The mean score according to AOFAS was 90.2 (87–100). They found that the type of fracture and the accuracy of the operative reduction correlated directly with the final clinical result.

Here, our study was carried out on 10 patients with displaced navicular body fractures: two type I, seven type II, and one type III. All of them were treated using the same surgical technique. According to the AOFAS score, the postoperative mean clinical score was 90.4 (85–100). There was no recorded postoperative complication that condemns this technique.

Use of the spanning fixator as a definitive method not only intraoperatively to visualize the fractured fragments is of paramount importance as it maintains the length of the navicular without collapsing or without the need for a bone graft, thus preventing loss of the medial longitudinal foot arch.

We acknowledge that the limitations of our study include a relatively small number of patients and that a greater number of patients are needed for more robust conclusions. Nevertheless, we believe that our work lends support to the notion that open reduction and internal fixation of displaced body fractures of the navicular bone is a safe and a satisfactory procedure to restore anatomical realignment of the midfoot.

Conclusion

Because the navicular is the keystone of the foot's medial longitudinal arch, and intimately involved in hindfoot motion and effective locomotion, most navicular body fractures should be treated with open reduction and internal fixation. However, in those fractures that are nondisplaced, as well as in the setting of avulsion injuries, conservative interventions are appropriate.

Acknowledgements

Conflicts of interest

There are no conflicts of interest.

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