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ISOLATED TARSAL NAVICULAR FRACTURE-DISLOCATION

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Isolated tarsal navicular fracture-dislocation

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ABSTRACT: **Nine cases of fracture-dislocation of the tarsal navicular are reported. Six patients were male and three were female. Their mean age at the time of injury was 30.4 years old. The cause of the injury was a traffic accident in five cases and a fall from a height in four. Open reduction and internal fixation was performed in four cases (three by Kirschner wire, one by screw) and plaster fixation in four. Bony union was achieved in every case, except one chronic case. Arthropathic change was observed in two cases. No aseptic necrosis was found at follow-up. Pain on walking persisted in two cases. None of the patients complained of significant interference with ADL.**

Fracture-dislocations of the tarsal navicular are very rare, because the tarsal navicular is a small bone that is protected by surrounding bones and tightly bound by strong ligaments. These fractures usually occur in combination with fracture-dislocation of Lisfranc's joint, because forces great enough to cause fracture-dislocation of the tarsal navicular cause other fracture-dislocations at weaker sites. Thus, isolated navicular fracture-dislocation is extremely rare.

Fractures without significant displacement were treated conservatively by plaster cast. Fracture-dislocations were reduced surgically and fixed internally, because manual reduction was difficult and dislocation was prone to recur.

KEY WORDS: **tarsal navicular, fracture, dislocation, treatment, pathomechanism**

INTRODUCTION

Fracture-dislocations of the tarsal navicular are very rare because the tarsal navicular is a small bone protected from external forces by surrounding bones and rigidly bound to them by thick, strong ligaments on both its plantar and dorsal aspect. Fracture-dislocations of the tarsal navicular usually occur in combination with fracture-dislocations of Lisfranc's joint, because forces great enough to cause fracture-dislocation of the tarsal navicular cause other fracture-dislocations at weaker sites, such as Lisfranc's joint. Thus, isolated fracture-dislocation of the tarsal navicular is extremely rare. Reports on this fracture-dislocation have been limited and the cause of the injury, types of fracture, treatment and prognosis remain unclear. We report 9 cases of isolated fracture-dislocation of the tarsal navicular caused by isolated injuries.

MATERIALS AND METHODS

Nine patients with isolated fracture-dislocation of the tarsal navicular were treated at our institute between 1981 and 1994. Six of the patients were male and three were female. Their average age at the time of injury was 30.4 years old (range: 16 to 48 years old). The right side was affected in six cases and the left in three. The cause of the injury was a fall in 4 patients and a motor vehicle accident in 5. Fracture-dislocation of the Lisfranc joint on the opposite side was also present in one patient and a calcaneal fracture on the opposite side in two patients. According to Main's [1] classification of fractures of the body of the tarsal navicular, four cases were F1, three F2, one F3 and one could not be classified. According to Sangeorzan's [2] criteria, none was Type-1, six Type-2, two Type-3, and one could not be classified. Four patients were treated conservatively by plaster cast, four patients were treated by reduction and surgical fixation (three with Kirschner wires, one with screws) and the patient's course was observed in one, with no specific treatment.

RESULTS

Nine patients were followed for an average of thirty-eight months (range:12 to 72 months).

Apart from one chronic case, solid bony union was achieved in all cases. Aseptic necrosis was not detected in any of the patients at follow-up. Two patients developed arthropathic changes, but there was no limitation of activities of daily living (ADL) and none of the patients required a second operation.

CASE REPORTS

Case 1. A 28-year-old male injured his left foot when he fell from a roof at work. Plain radiographs revealed a fracture of the body of the tarsal navicular with dorsal dislocation (Fig. 1A). The fracture was classified as F2 by Main's[1] criteria and Type-2 by Sangeorzan's[2] criteria. When manual reduction failed, open reduction and internal fixation with two screws was performed. The screws were removed 8 months after the operation when bony union was confirmed. The patient has no difficulty in performing daily activities, but there are osteoarthritic changes at the cuneonavicular joint 4 years after the injury (fig. 1B).

Case 2. A 30-year-old male injured his right

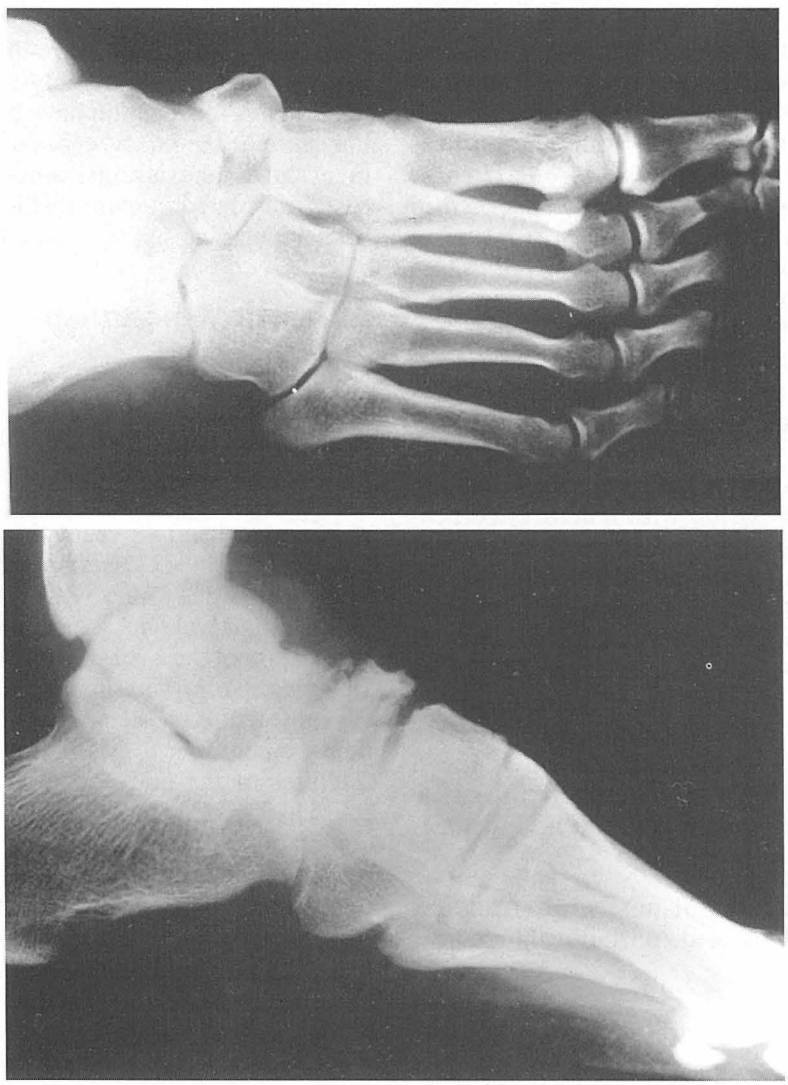

Fig. 1. - Case 1: (A) Oblique view at the time of injury shows a fracture of the navicular transverses from dorsal-lateral to plantar-medial and that the medial fragment has subluxed dorsally and medially (Type-2). The fracture line corresponded to the septum between the medial and intermediate cuneiforms bones (F2).
(B) Lateral view radiograph of one year after the injury reveals arthropathic changes in talo-navicular and naviculo-cuneiform joints.

foot when he jumped from a height in a suicide attempt. Radiographs revealed fracture-dislocation of the right tarsal navicular (Fig. 2A) and a left calcaneal fracture. This navicular fracture was classified as F2 by Main's [1] criteria and Type-2 by Sangeorzan's [2] criteria. Open reduction and internal fixation with Kirschner wires was performed (Fig. 2B). Compression deformity of the tarsal navicular and incongruity of the talonavicular joint remained, but aseptic necrosis had not occurred 6 years after the injury. At follow-up the patient complained of only slight pain on running.

Fig. 2. - Case 2: (A) Lateral view at the time of injury shows a large medial fragment is displaced dorsally and medially and that the smaller, lateral fragment articulate with the head of the talus (Type-2).
(B)Antero-posterior view reveals the medial fragment has been reduced into the space between the talar head and medial cuneiforms and fixed with Kirschner wires.

Case 3. A 16-year-old female injured her left foot when she missed her step on stairs. While the tarsal navicular was compressed, since joint incongruity was good (Fig. 3A, B), a plaster cast was applied. This fracture could not be classified either by Man's criteria or by Sangeorzan's. Bony union was achieved 6 weeks later. The patient has no limitation in daily activities or pain 5 years after the injury in spite of persistent irregularity of the articular surface.

Case 4. A 20-year-old male fell from a height and injured his right foot. The fracture was in the sagittal plane and in the area between the lateral and intermediate cuneiforms bones (F1) (Fig. 4). The patient was treated conservatively by plaster cast, because displacement of the fragment was minimal. It was difficult to classify this fracture by Sangeorzan's criteria, but it may have been Type-2.

Case 5. A 48-year-old female injured her left foot in a traffic accident. The fracture was classified as F1 by Main's criteria and possibly Type-2 by Sangeorzan's criteria (Fig. 5). A calcaneal fracture was also present on the opposite side. Open reduction and internal

Fig. 3. - Case 3: Compression fracture of the navicular in the coronal plane is revealed in an antero-posterior view (A) and lateral view (B) at the time of injury.

Fig. 4. - Case 4: 20-year-male

Fig. 5. - Case 5: 48-year-old female

fixation with Kirschner wire was performed.

Case 6. A 46-year-old male injured his right foot in a traffic accident. A radiograph showed that the fracture was in the area between the lateral and intermediate cuneiform bones (F1), that the lateral fragment was comminuted and the cuneonavicular joint disrupted (F2) (Fig.6). Treatment-Plaster immobilization.

Case 7. A 37-year-old male injured his right foot in a motor vehicle accident. The radiograph did not reveal clear disruption of the cuneonavicular joint, but this fracture could be classified as Type-3 by Sangeorzan's criteria (Fig.7). Conservative treatment by plaster cast was performed.

Case 8. A 30-year-old female injured her left foot in a traffic accident. The radiograph revealed that the fracture was at the border between the medial and intermediate cuneiforms and that the larger, medial fragment had subluxated medially and dorsally (Fig. 8). A Lisfranc's fracture-dislocation was also present on the opposite side. Open reduction and internal fixation with Kirschner wire was performed.

Case 9. A 19-year-old male injured his right foot in a traffic accident. The fracture had occurred along the medial border of the medial cuneiforms bones (F3) and the medial fragment had subluxated medially and dorsally (Type-2) (Fig. 9). This was a chronic fracture and its course was observed without treatment.

Fig. 6. - Case 6: 46-year-old male

Fig. 7. - Case 7: 37-year-old male

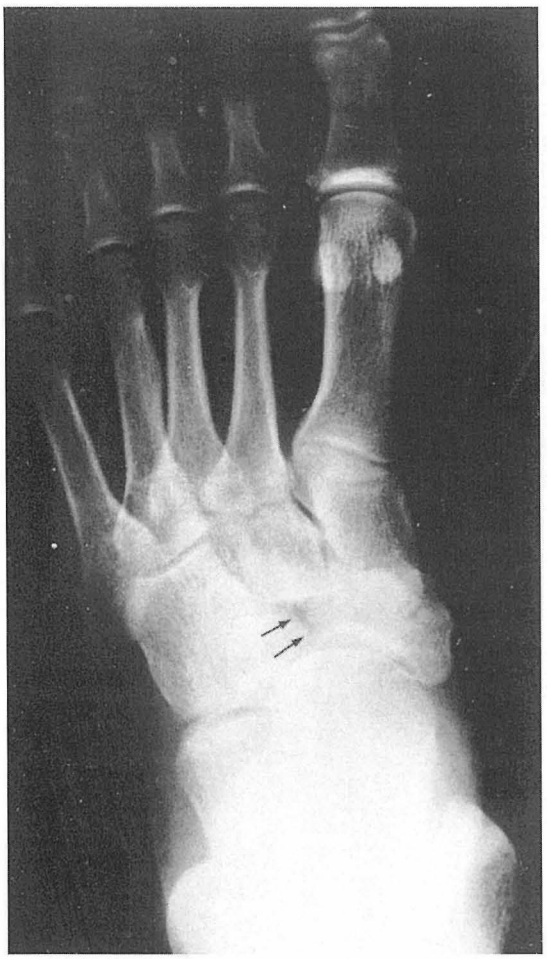

Fig. 8. - Case 8: 30-year-old female.

Fig. 9. - Case 9: 19-year-old male.

Table I
ISOLATED FRACTURE-DISLOCATIONS OF THE TARSAL NAVICULAR

	Name	Age y.o.	Sex	Side	Type of fracture Main	Sangeorzan	Cause	Treatment	Complication
1	T.M.	28	male	left	F2	Type-2	fall from a roof	ORIF (screw)	
2	H.T.	30	male	right	F2	Type-2	fall from a height	ORIF (K-wirw)	Calcaneus Fx. on opp. side
3	H.H.	16	female	right			fall from astairs	plaster fix.	
4	F.O.	20	male	right	F1	Type-2	fall from a height	plaster fix.	
5	C.M.	48	female	left	F1	Type-2	traffic accident	ORIF (K-wirw)	Calcaneus Fx. on opp, side
6	K.Y.	46	male	right	F1	Type-3	traffic accident	plaster fix.	
7	K.I.	37	male	right	F1	Type-3	traffic accident	plaster fix.	
8	R.I.	30	female	left	F2	Type-2	traffic accident	ORIF (K-wirw)	Lisfranc fx.-disl. on opp. side
9	K.K.	19	male	right	F3	Type-2	traffic accident	only inspection	

ORIF: Open reduction and internal fixation

DISCUSSION

Fracture-dislocations of the tarsal navicular are rare because the navicular is protected by the surrounding bones and is rigidly bound to them by strong ligaments on both the plantar and dorsal side. According to Wilson,[3] the incidence of navicular fracture-dislocation is 0.26% of all fractures. Eichenholtz[4] reported only nineteen cases of isolated tarsal navicular body fracture in a twenty-six-year review before 1964. Only four cases have been reported in Japan, all by Norimatu.[5]

Main[1] explained the mechanism of injury of fractures of the tarsal navicular as compression of the cuneiform bone to shearing force. Eichenholtz[4] stated that rupture of the dorsal ligaments causes fractures of the tarsal navicular. In Japan, Norimatsu[5] concluded that this fracture is caused by external force directed from the tip of the foot. Wiley[6] explained that external force and torsion on the longitudinal axis of the foot injure the ligaments and produce fracture-dislocation. Examination of our patients, who were injured in falls from a roof or stairs and had contralateral fracture-dislocations of Lisfranc's joint as complications, support Wiley's[6] explanation.

The categories of fracture in the Watson-Jones classification are 1) fractures of the tuberosity, 2) fractures of the dorsal lip, and 3) transverse fractures with dislocation of the dorsal fragment. De Palma and Wilson[3] devised similar classifications. Main[1] classified fractures of the body of the tarsal navicular from F1 to F3. Fractures along the line extending from the border between lateral and intermedial cuneiforms is an F1 injury, and between the intermedial and medial cuneiforms a F2 injury. A F3 injury is almost the same as a tuberosity fracture. In our series, five fractures were F1, three F2 and one F3. Sangeorzan[2] classified tarsal navicular fractures into three types. In Type-1 fractures, the fracture line is in the coronal plane and there is no angulation of the fore part of the foot. In Type-2 fractures, the primary fracture line is dorsal-lateral to plantar-medial, and the major fragment and the fore part of the foot are displaced medially. In Type-3 injuries, there is a comminuted fracture in the sagittal plane of the body of the tarsal navicular, and the fore part of the foot is laterally displaced. There were four Type-1, twelve Type-2 and four Type-3 fractures in their series, and one Type-1, four Type-2 and four Type-3 fractures in our own series.

Day[7] recommended manual reduction (with wire traction) as the treatment of first choice, and Penhallow[8] and Lehman[9] reported success case by manual reduction. Holmes,[10] however recommended surgery because of frequent recurrence of dislocations. Arthrodesis instead of open reduction and internal fixation of the fracture had been recommended in most reports before Sangeorzan[2]. Sangeorzan stated that only four cases of tarsal navicular fracture treated by primary ORIF had been reported in the 25 years before they reported 21 of their cases, and that both the type of fracture and accuracy of the operative reduction directly correlated with the final clinical outcome. In spite of the failure of closed treatment, the efficiency of primary ORIF, as in our cases, has not been established. Since our cases had a good outcome, even though the follow-up period (1-6 years), has been short, we feel that open reduction and internal fixation should be performed before arthrodesis. Arthritic changes appear shortly after surgery, as mentioned in other reports, and can be explained by the fact that the tarsal navicular, the keystone in the longitudinal axis of the foot, is subject to stress. Mestdagh[11] reported the occurrence of aseptic necrosis some cases and Sangeorzan[2] found aseptic necrosis in six patients in 21 their series, but this complication did not develop in any of our patients.

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