Total dislocations of the navicular: are they ever isolated injuries?

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Isolated dislocations of the navicular are rare injuries; we present our experience of six cases in which the navicular was dislocated without fracture. All patients had complex injuries, with considerable disruption of the midfoot. Five patients had open reduction and stabilisation with Kirschner wires. One developed subluxation and deformity of the midfoot because of inadequate stabilisation of the lateral column, and there was one patient with ischaemic necrosis. We believe that the navicular cannot dislocate in isolation because of the rigid bony supports around it; there has to be significant disruption of both longitudinal columns of the foot. Most commonly, an abduction/pronation injury causes a midtarsal dislocation, and on spontaneous reduction the navicular may dislocate medially. This mechanism is similar to a perilunate dislocation. Stabilisation of both medial and lateral columns of the foot may sometimes be essential for isolated dislocations. In spite of our low incidence of ischaemic necrosis, there is always a likelihood of this complication.

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Midtarsal injuries are the result of complex multidirectional forces. The bones of the midfoot fit snugly to one another and are shaped to form transverse and longitudinal arches. The navicular, the keystone of the medial longitudinal arch, is rigidly stabilised by an extensive network of dorsal and plantar ligaments. Because of the strong ligamentous attachments and the recessed position of the navicular, fractures are much more common than dislocations. The usual mechanism is a plantar flexion/compressive injury, which crushes the bone and may sometimes displace a part of the fractured bone from the naviculocuneiform and the talonavicular joints. This usually occurs when an element of longitudinally directed force compresses the navicular, in addition to an abduction/plantar flexion injury. Isolated dislocations without fractures of the body are extremely rare, and it has been claimed that dislocation without fracture is an anatomical impossibility since the foot is composed of two longitudinal columns, the lateral and the medial, each adding to the stability of the other. Consequently, for the navicular to dislocate completely without fracture, there must be a break in both columns, with marked instability. We have reviewed all patients seen at our institute in whom the navicular was found to be dislocated without a fracture of the body, in order to analyse the mechanism and forces involved. A review of the literature from 1920 onwards revealed only six cases of either total or isolated dislocations of the navicular.

Patients and Methods

Between 1990 and 1997, we encountered six patients in whom the navicular had dislocated from the talonavicular as well as the naviculocuneiform joints without a fracture of the body. These injuries were six of 35 complex midtarsal fractures/dislocations seen during this period. The records of the mechanism of trauma, the nature of the injury, the clinical details and radiographs taken when first seen (Fig. 1) and at the last follow-up, were reviewed. All patients were seen primarily at our centre and four were reviewed in the period between September 1997 and September 1998.

The details of these six patients are given in Table I. There were five men and one woman with a mean age of 35.8 years (24 to 60). One patient (case 5) has been reported elsewhere. Five patients were injured in road-traffic accidents. One had an injury from a buffalo’s hoof. One (case 6) had multiple injuries, and management of the foot was given low priority. The dislocated navicular was observed to lie inferomedially to the head of the talus in three patients (Fig. 2). One (case 3) had a complete naviculocuneiform dislocation, but partial dislocation of the talonavicular joint...
Case 1. Figure 1a – Lateral radiograph showing a gap between the talus and the medial cuneiform, with inferior subluxation at the midtarsal joint. Figure 1b – Anteroposterior view showing the navicular lying on the medial surface of the foot.

Case 2. Figure 2a – Anteroposterior radiograph showing medial dislocation of the navicular. The arrow indicates the subluxation at the calcaneocuboid joint and there is a flake fracture. Figure 2b – Oblique view showing the vacant space between the talus and the cuneiform. Figure 2c – After open reduction and internal fixation. There is residual subluxation at the naviculocuneiform joint (large arrow) and a fracture at the calcaneocuboid joint (small arrow).

Table I. Details of the six patients with injury to the foot

<table>
<thead>
<tr>
<th>Case</th>
<th>Age (yr)</th>
<th>Gender</th>
<th>Side</th>
<th>Mechanism of injury</th>
<th>Dislocation type</th>
<th>Associated injury</th>
<th>Treatment</th>
<th>Result</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>45</td>
<td>F</td>
<td>Right</td>
<td>Car overturned</td>
<td>Inferomedial, 90° rotation of navicular</td>
<td>Subluxation/fracture of calcaneocuboid joint</td>
<td>Refused surgery</td>
<td>Lost to follow-up</td>
</tr>
<tr>
<td>2</td>
<td>40</td>
<td>M</td>
<td>Right</td>
<td>Tractor collision, foot trapped</td>
<td>Inferomedial, 60° rotation of navicular</td>
<td>Subluxation/fracture of calcaneocuboid joint</td>
<td>Open reduction, Kirschner-wire fixation</td>
<td>Residual subluxation, some pain</td>
</tr>
<tr>
<td>3</td>
<td>27</td>
<td>M</td>
<td>Left</td>
<td>Vehicular collision, open injury</td>
<td>Medial, complete nav-cuneiform, incomplete talonavicular</td>
<td>Subluxation calcaneocuboid joint, fracture of mid cuneiform?</td>
<td>Open reduction, Kirschner-wire fixation, skin grafting</td>
<td>Patient died</td>
</tr>
<tr>
<td>4</td>
<td>60</td>
<td>M</td>
<td>Left</td>
<td>Buffalo hoof injury</td>
<td>Inferomedial, 90° rotation of navicular</td>
<td>Subluxation/fracture of calcaneocuboid joint, fracture of base of 5th metatarsal</td>
<td>Open reduction, Kirschner-wire fixation</td>
<td>Excellent</td>
</tr>
<tr>
<td>5</td>
<td>60</td>
<td>M</td>
<td>Left</td>
<td>Tractor overturned, open injury</td>
<td>Subsustentacular, 90° rotation</td>
<td>Superolateral midtarsal dislocation</td>
<td>Open reduction, Kirschner-wire fixation, delayed flap cover</td>
<td>AVN, lateral midfoot collapse, midtarsal arthrodesis</td>
</tr>
<tr>
<td>6</td>
<td>24</td>
<td>M</td>
<td>Right</td>
<td>Vehicular collision, compound</td>
<td>Navicular medial to talar head, lateral to cuneiform, 90° rotation</td>
<td>Ankle dislocation, medial midtarsal dislocation</td>
<td>Open reduction, Kirschner-wire fixation</td>
<td>Stiff foot, AVN talus</td>
</tr>
</tbody>
</table>
with the navicular lying medially to the talus (Fig. 3). Two unusual situations were encountered. One patient (case 5) had a subsustentacular dislocation, with a midfoot break, while in another (case 6) the navicular had shifted medial to the talar head, but lateral to the cuneiform. None of these examples was an isolated injury. There was disruption at the midtarsal joint laterally, and sometimes distally in the medial column. Five patients had an open reduction and fixation with Kirschner wires. All were immobilised in a plaster cast after surgery. One patient (case 1) refused operation and was discharged in a plaster back slab. One patient died in the immediate postoperative period.

We were able to contact four patients and three agreed to attend for review. One (case 4) had an excellent clinical and...
radiological result 3.5 years after the injury. Another (case 2) had pain on prolonged standing, with some residual subluxation apparent on the radiographs. He used supports in his shoe and regularly took analgesics. One patient (case 5), who had the most unusual type of injury, was initially stabilised inadequately and the forefoot subluxated after operation. The wound became infected and the navicular eventually had avascular necrosis of the navicular (AVN) which required treatment.

Of the three patients available for review, only one (case 5) had avascular necrosis of the navicular (AVN) which required treatment.

Discussion

Isolated dislocations of the tarsal bones are rare with only the occasional case reported.5,8,9,12,13 We were able to find only six reported cases which could be labelled as complete or ‘isolated’ dislocations without fractures of the body of the navicular (Table II). On detailed assessment of these reports, it is apparent that they were not isolated navicular injuries since all the patients had associated fractures in the lateral column of the foot, or an unstable midfoot break and significant disruption of the soft tissues.

The mechanism of injury of a pure navicular dislocation is still unclear. Dixon7 described a case in which the navicular had dislocated plantarwards, and he proposed that the mechanism of injury was a transient midtarsal dislocation with a concomitant second direct blow causing dislocation of the navicular. After analysing the six cases in our series and examining the dislocations which had been reported previously in detail, we believe that the mechanism of dislocation is more complex. The medial longitudinal column consists of the talus, the navicular, the three cuneiforms and the corresponding metatarsals, and the lateral of the calcaneus, cuboid and the lateral two metatarsals.5 The resultant configuration is analogous to a three-legged stool, with the calcaneus as its base. The stability of the foot is ensured by the rigidity of both of these columns, and each supports the other. With this concept, it is impossible to sustain an isolated dislocation at any level in either of the two bony columns, without disruption of the bony or ligamentous anatomy of the adjacent column. In order to produce a complete dislocation of the navicular without fracture, a midtarsal dislocation or subluxation (complete or transitory) must occur. This dislocation involves extensive disruption of both the dorsal and plantar ligaments attached to the navicular, as well as to the medial, lateral and capsular structures. In our series, five of the six dislocated bones were lying on the medial aspect of the talus, with varying degrees of rotation in the longitudinal plane. All patients had some form of lateral injury, either in the form of fracture subluxation of the calcaneocuboid joint or frank midtarsal dislocation. It is presumed that with an abduction/pronation injury, the midfoot initially breaks at the navicular-cuneiform joint in the medial column; the force also causes a break at a similar point laterally at either the calcaneocuboid joint or lateral tarsometatarsal joint, to produce an occult or frank midtarsal dislocation. The forefoot displaces either superolaterally or inferolaterally, depending on the deforming forces, and the subsequent relocation of the forefoot then pushes the navicular from the talonavicular joint. Depending on the direction of the forces, as well as the residual soft-tissue attachments to the bone, the navicular can be dislocated to various positions medially. This is similar to the mechanism of lunate/perilunate dislocation in the wrist in which the displacement of the lunate does not occur in isolation, but depends

Table II. Review of literature for complete or isolated navicular dislocations

<table>
<thead>
<tr>
<th>Authors</th>
<th>Age (yr)</th>
<th>Gender</th>
<th>Type of trauma*</th>
<th>Dislocation type</th>
<th>Associated injury</th>
<th>Treatment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Berman7</td>
<td>17</td>
<td>M</td>
<td>Complete dislocation</td>
<td>Animal hoof injury</td>
<td>Inferomedial</td>
<td>Fracture cuboid</td>
</tr>
<tr>
<td>Dixon7</td>
<td>52</td>
<td>M</td>
<td>Isolated dislocation</td>
<td>Heavy plate</td>
<td>Plantar/medial</td>
<td>Fracture base of 5th metatarsal</td>
</tr>
<tr>
<td>Hooper and Hughes12</td>
<td>Unknown</td>
<td>Unknown</td>
<td>Complete dislocation</td>
<td>Unknown</td>
<td>Dorsal</td>
<td>Insignificant bony damage</td>
</tr>
<tr>
<td>Pathria et al8</td>
<td>27</td>
<td>M</td>
<td>Isolated dislocation</td>
<td>RTA, planar flexion/inversion</td>
<td>Dorsomedial</td>
<td>Fracture calcaneocuboid joint, fracture metatarsals 3,4</td>
</tr>
<tr>
<td>Freunda9</td>
<td>43</td>
<td>M</td>
<td>Isolated dislocation</td>
<td>RTA, plantar flexion</td>
<td>Dorsal</td>
<td>Fracture of inferior pole of navicular</td>
</tr>
<tr>
<td>Puente et al10</td>
<td>65</td>
<td>F</td>
<td>Midtarsal fracture dislocation</td>
<td>Unknown</td>
<td>Plantar</td>
<td>Fracture metatarsals 2-4, cuboid, int. cuneiform</td>
</tr>
</tbody>
</table>

* RTA, road-traffic accident

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on the dislocation or relocation of the rest of the carpus. This mechanism explains five of our cases. Case 6 was probably a complex wringing injury of the foot in which the talus dislocated at the ankle, and then at the talonavicular articulation; the force continued to cause a medial midtarsal dislocation at the navicolocuneiform joint, leaving the navicular free and rotated. Pathria et al postulated a similar mechanism in their case of dorsal dislocation in which the deforming force was plantar flexion.

On occasion the lateral part of the foot may not fully dislocate, but a similar injury hinging on the lateral column will exert a squeezing effect on to the inferolateral aspect of the navicular. This will result in fracture of the body with dislocation of the medial component. When the deforming force leads to forced plantar flexion dorsal displacement of the fractured navicular will occur.

The attachment of the soft tissues may play a part in the stability as well as the direction of the dislocation. The tendon of the tibialis posterior gives slips of insertion medially to all the bones of the midfoot, and inserts close to the plantar ligaments. In certain circumstances it may be the only soft-tissue structure left attached to the dislocated navicular. It may be responsible for the most common direction of the dislocation, medial, or unusual placement of the dislocated bone as in case 5 (Table I). It may also be the only residual blood supply to the bone, and careful dissection is essential to preserve it during reduction. There is a high risk of AVN when the dislocated bone lies far away from its original position. In our patients only one with subsustentacular dislocation developed AVN. Only one reported case (Table II) had features of ischaemic necrosis at ten weeks of follow-up.

Accurate reduction of the dislocated navicular is imperative. The whole midfoot is potentially unstable and both columns of the foot may need to be stabilised to prevent late subluxation, as in case 5. If the foot reduces easily the injury is more unstable. Sometimes, the lateral injury may be purely ligamentous; an accurate assessment of the radiographs is required to define the full extent of instability and to understand all elements of the injury. CT, although not undertaken in our series, would be a valuable adjunct.

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References