

# Fractures of the Tarsal Navicular Bone: A Retrospective Study of Thirty Cases.

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## ABSTRACT

**Background:** Navicular fractures are usually caused by high velocity trauma, sudden twisting forces (sports injury) and repeated minor trauma (as seen in military recruits or athletes). The patients usually present with pain and swelling. Stress fractures usually present with vague symptoms and the diagnosis is delayed leading to complications. The diagnosis is usually done on the basis of imaging. The undisplaced fractures are managed conservatively while displaced fractures need surgical intervention. Usual complication in surgically treated patients may include prolonged pain, stiffness, arthritis and avascular necrosis. Aims and Objectives: To study the mechanism of injury, presenting complaints, management and outcome of patients with navicular fractures. **Methods:** This was a retrospective study conducted in the department of orthopedics of a tertiary care medical college situated in an urban area. 30 patients diagnosed to be having navicular fractures and treated either by conservative or surgical methods were included in this study on the basis of a predefined inclusion and exclusion criteria. The etiology, type of fractures, management and outcome were studied in this study on the basis of patient records. Follow up record of at least 2 years after surgery was reviewed in all the cases. **Results:** Out of the 30 studied cases there were 22 males and 8 females with a M:F ratio of 1:0.28. Most common affected age group was found to be 21-30 years. Mean age of male and female patients was found to be 28.77 +/- 7.90 and 29.12 +/- 8.58 respectively. Right navicular bone was affected in majority of the cases and most common type of injury was found to be road traffic accidents. Simple undisplaced fractures were seen in majority of the cases. Conservative management was done in 19 patients while 11 patients were treated by surgical interventions. complications like sudeks atrophy, wound infection and long term pain and stiffness were seen in 7 patients. **Conclusion:** Navicular fractures are commonly seen in young athletes. The management is either conservative or surgical depending upon type of fracture. Early diagnosis and proper treatment is crucial as delay in management is associated with complications.

**Keywords:** Navicular Fracture, Imaging, Stress fractures, surgical intervention, complications.

## INTRODUCTION

The navicular bone is one of the tarsal bone responsible for maintaining the medial longitudinal arch of the foot. The common pathologies affecting navicular bone include fractures, avascular necrosis (Kohlers disease), osteomyelitis, degenerative changes and neoplastic diseases.<sup>[1]</sup> The fracture of navicular bone is one of the common pathologies of navicular bone encountered in orthopedics practice. The types of navicular fractures include cortical avulsion, fracture of navicular tuberosity, fracture

involving body of navicular bone and stress fracture. It is very difficult to appreciate fractures of this bone on plain radiography hence the diagnosis of navicular fracture is often delayed. This delay in diagnosis and management usually result in prolonged pain and restricted function of involved foot.<sup>[2]</sup> The most common mechanism of fracture involving navicular bone is avulsion fracture and usually involve cortical or tuberosity of navicular bone. The mechanism of injury is usually twisting forces applied on midfoot. These fractures are usually managed conservatively except in cases where there is avulsion of the posterior tibial tendon. The fracture of the body of navicular bone can be divided into types depending upon whether it's a fracture without dislocation (Type I), fracture with medial forefoot displacement (Type II) or there is comminuted fracture (Type III).<sup>[3]</sup> Lastly the stress fractures

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which is usually seen in athletes or individuals who are employed in highly physically demanding occupations are the type of fractures which are usually diagnosed late and have a potential to cause significant disability. The average time from the fracture to the diagnosis is reported to be 7-8 months.<sup>[4]</sup> The patients with navicular fractures often present with history of pain preceded by episode of forceful and sudden twisting of foot (acute avulsion fracture), or history of symptoms immediately after participating in sports competition (acute fracture). The patients with stress fracture usually are involved in activities such as dancing activities, basketball, soccer or military training.<sup>[5]</sup> These activities cause repeated minor trauma to navicular bone resulting in stress fracture. The diagnosis usually is confirmed by imaging. Plain radiographs are not sensitive for the diagnosis of navicular bone fracture and hence a negative X-ray foot can't rule out presence of navicular fracture with certainty.<sup>[6]</sup> 3D CT of the foot is a very reliable investigation for the diagnosis of navicular fractures. Not only fractures can be diagnosed with confidence but also it can better define the location and extent of the fracture. Magnetic resonance imaging is especially useful in the diagnosis of stress fractures. Moreover, surrounding soft tissue is also better imaged by MRI. Bone scanning and ultrasonography are other imaging techniques which theoretically can be used but these tests are not routinely used as their specificity is low.<sup>[7]</sup>

Management of navicular fracture depends upon the type of feature. Uncomplicated and undisplaced fractures are usually treated conservatively while displace and complicated fractures require surgical intervention and open reduction and internal fixation is required.<sup>[8]</sup> The long-term complications of both conservative as well as operative management are persistent pain, stiffness, loss of hindfoot motion, arthritis and avascular necrosis.<sup>[9]</sup> We conducted this retrospective study of patients who presented to us with navicular bone fractures and were treated either conservatively or by surgical intervention.

## MATERIALS AND METHODS

This was retrospective study conducted in the department of orthopaedics of a tertiary care medical college situated in an urban area. 30 patients over the age of 18 years who had been admitted and diagnosed to be having navicular fractures were included in this study depending upon a predefined inclusion and exclusion criteria. The detailed history was noted from the inpatient files of the admitted patients. Particularly the history of involvement in athletic sports and twisting injuries was searched for. Symptoms like pain in the midfoot increasing with push-off and

inability to bear any weight was looked into. A detailed clinical examination was noted from the hospital record. Presence of substantial swelling of the dorsal and medial aspects of the midfoot and presence of any open wound and whether navicular tenderness was present at the time of presentation was noted. Imaging reports like X-Ray foot anteroposterior and lateral view and 3D CT (if done) was reviewed with the help of a senior radiologist. The fractures were classified into type-1 (body injury which was characterized by a transverse fracture line in the coronal plane), type-2 fracture by a primary fracture line extending dorsal-lateral to plantar-medial, with the major fragment and forefoot displaced medially) and type-3 injury (comminuted fracture).

**Table 1: American Orthopedic Foot & Ankle Society (AOFAS) scores**

<b>Pain (Max- 40 points)</b>	
None	40
Mild, occasional	30
Moderate, daily	20
Severe, almost always present	0
<b>Activity limitations, support (Max- 10 points)</b>	
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
<b>Maximum walking distance, blocks (Max- 10 points)</b>	
Greater than 6	10
4-6	7
1-3	4
Less than 1	0
<b>Footwear requirements (Max- 5 points)</b>	
Fashionable, conventional shoes, no insert required	5
Comfort footwear, shoe insert	3
Modified shoes or brace	0
<b>Walking surfaces (Max-10 points)</b>	
No difficulty on any surface	10
Some difficulty on uneven terrain, stairs, inclines, ladders	5
Severe difficulty on uneven terrain, stairs, inclines, ladders	0
<b>Gait abnormality (Max-10 points)</b>	
None, slight	10
Obvious	5
Marked	0
<b>Alignment (Max-15 points)</b>	
Good, plantigrade foot, midfoot well aligned	15
Fair, plantigrade foot, some degree of midfoot malalignment observed, no symptoms	8
Poor, nonplantigrade foot, severe mal-alignment, symptoms	0
Total=100	

The management of navicular fracture was done on the basis of type of fractures as per institutional protocol. Undisplaced, small avulsion fractures and stress fractures were treated by non-weight bearing cast for 6 weeks. Surgical Intervention (Open reduction and internal fixation) in cases where there was dislocation of talonavicular or naviculocuneiform joints. The goal of surgical

management was anatomic fracture reduction, restoration of medial column length, and the creation of normal osseous anatomy allowing for early range of motion. Screws and plates were used in large avulsion fractures and whenever necessary in cases of displaced fragments of bones. Follow up record of the patients was studied at least for 2 years. Whenever the patients record was not available then a telephonic conversation was made and the symptoms like persistent pain, stiffness and range of motion were enquired into. The patients who could not be traced or the patients whose 2 years' follow up record was not available were excluded from the study. The outcome of patients who were treated either by non-weight bearing cast or by operative intervention in the form of open reduction and internal fixation was studied using American Orthopedic Foot & Ankle Society (AOFAS) scores.

The data was analyzed using SSPE 16 version software. Microsoft excel was used to tabulate the data while Microsoft office-2016 was used for preparing charts and graphs. P value less than 0.05 was taken as statistically significant.

**Inclusion Criteria**

1. All the patients above 18 years of age and diagnosed to be having navicular fracture on the basis of imaging.
2. Patient whose follow up record of 2 years could be reviewed.
3. In cases of patients who didn't come for follow up for 2 years but they could be contacted and their outcome could be reliably found out.

**Exclusion Criteria**

1. Patients less than 18 years of age.
2. Patients who were lost to follow up in less than 2 years after discharge from hospital.
3. Patients whose 2 years follow up record was not present and they could not be contacted to know outcome.

**RESULTS**

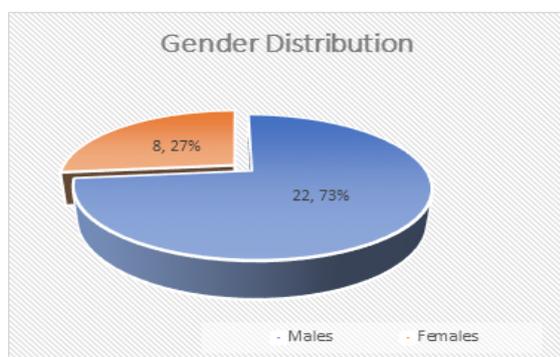


Figure 1: Gender distribution of the studied cases.

This was a retrospective study of 30 cases of navicular fractures who were admitted and treated

in department of orthopedics of a tertiary care medical college. Out of these 30 studied cases there were 22 males (73.33 %) and 8 females (26.66 %) with a M:F ratio of 1:0.28.

The analysis of age distribution of the studied cases showed that the most common age group involved in cases of navicular fracture was found to be 21-30 years followed by 31-40 years and more than 40 years.

Table 2: Age distribution of the studied cases.

Age	No of patients	Percentage
< 20 years	-----	-----
20-30 years	16	53.33 %
31-40 years	10	33.33 %
> 40 years	4	13.33 %
Total	40	100 %

The mean age of the male patients was found to be 28.77 +/- 7.90 years while mean age of female patients was found to be 29.12 +/- 8.58 years. On statistical analysis the difference in mean age of male and female patients was found to be statistically insignificant. The age groups were found to be comparable in males and females.

Table 3: Mean age in male and female patients.

		P
Mean Age (Males)	28.77 +/- 7.90	P = 0.91
Mean Age (Females)	29.12 +/- 8.58	Not significant

Most of the patients had fractures of navicular bone on right side (18/30) followed by left navicular fracture (9/30). 3 patients had bilateral navicular stress fractures.

Table 4: Affected side in the studied cases.

Affected side	No of patients	Percentage
Right	18	40%
Left	9	30%
Bilateral	3	10%
Total	30	100

The most common mechanism of injury to navicular bone was found to be road traffic accidents (20/30) followed by twisting force during sport activity (7/30). 3 patients had no such history of acute injury but they were found to be involved in excessive physical work involving excessive brisk walking (labour work).

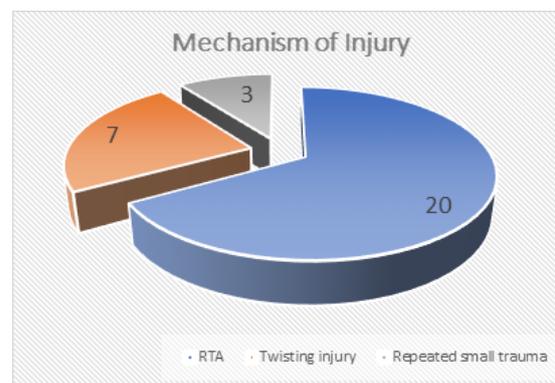


Figure 2: Mechanism of injury in affected cases.

Fractures of the navicular bone and their types were diagnosed on the basis of imaging. Though X-Ray was done in all the cases most of the diagnoses were confirmed on the basis of CT scans.

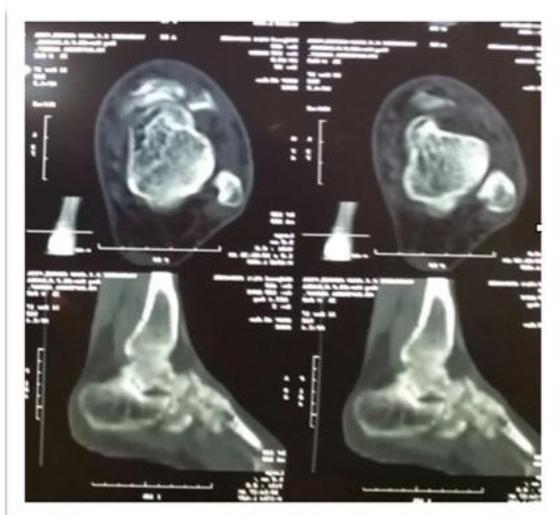


Figure 3: CT Scan Axial And coronal images showing fracture of the navicular bone.

The most common type of fracture was found to be simple undisplaced fractures (18/30) followed by small avulsion fractures (6/30), comminuted fractures (3/30) and bilateral stress fractures (3/30).

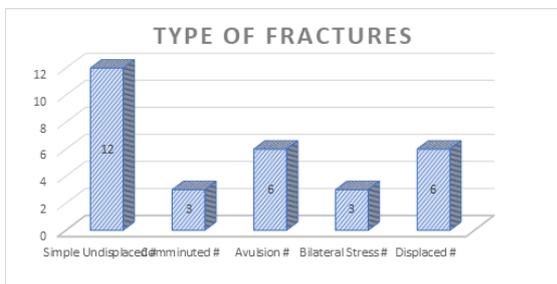


Figure 4: Type of fractures in studied cases.



Figure 5: Images showing (clockwise from left upper corner) Exposure of fracture site and reduction of navicular fracture, Postoperative X-Rays showing fracture fixed with K wires.

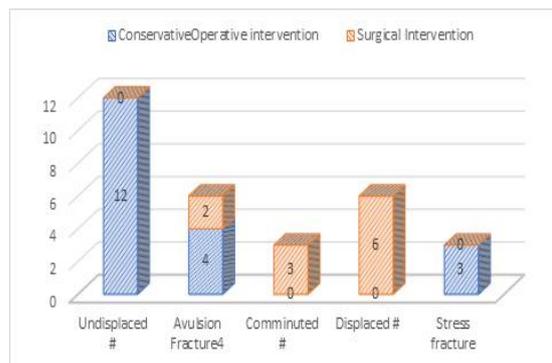


Figure 6: Type of management of affected cases.

The management record showed that out of 30 patients 12 patients who had simple undisplaced fractures were treated by weight-bearing short leg cast for six weeks followed by the use of walking boot for an additional four to six. Small avulsion fractures were also treated in similar fashion. Bilateral stress fractures were treated by non-weight-bearing in a short leg cast for six to eight weeks, with progressive weight-bearing in a walking cast or boot. Open reduction and internal fixation was done in cases of displaced and comminuted fractures of navicular bone.

The follow up record of the patients for outcome of treatment was assessed on the basis of American Orthopedic Foot & Ankle Society (AOFAS) scores. Mean AOFAS score was found to be 93.2. The analysis of patient records for complications showed that there were 3 patients with sudek's atrophy, wound infection occurred in 2 patients, long term pain and stiffness in 2 patients. Union was found to have been achieved in all patients. There were no cases of postoperative talonavicular or naviculocuneiform arthrosis requiring a secondary arthrodesis, avascular necrosis or hindfoot deformity over 2 years follow up period.

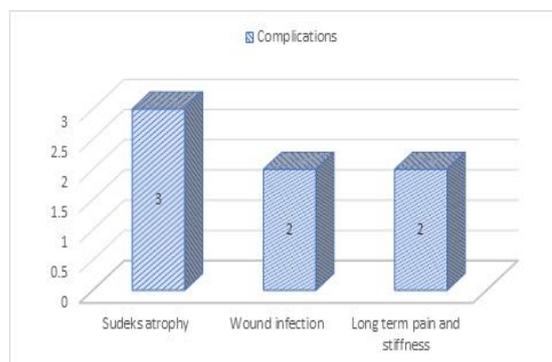


Figure 7: complications in the studied cases.

## DISCUSSION

This was a retrospective study of 30 patients with navicular fractures who were treated in the department of orthopedics of a medical college. In this study the males were predominantly affected

with a M:F ratio of 1:0.28. The predominant affection of men may be due to their involvement in sports activity as well as activities requiring extensive physical work. Similar male preponderance was found in the studies conducted by Coulibaly MO et al and Maquirriain J et al who reported M:F ratio of 1:0.57 and 1:0.52 respectively.<sup>[10,11]</sup> Saxena et al and few other authors reported a female preponderance but overall majority of the trials have found men to be affected more commonly than females.<sup>[12]</sup>

The mean age of males and females in our study was found to be 28.77 +/- 7.90 years and 29.12 +/- 8.58 years. Overall navicular fractures were seen in young males who were highly active. Similar findings were reported by Jacob KM et al who reported the mean age of patients with navicular fractures to be 22.8 years.<sup>[13]</sup> Daniel K. Ostlie et al have reported cases of navicular fractures in young athletes youngest being a girl of 13-year-old girl.<sup>[14]</sup> The authors recommended that tarsal navicular stress fractures should be considered in any patient presenting with vague, ill-defined foot especially if the patient is a young athlete. Similar findings were reported by Bennell KL et al.<sup>[15]</sup>

The common causes of navicular fractures include high energy trauma as seen in road traffic accidents, twisting injuries during competitive sports, avulsion fractures and stress fractures due to overuse and repetitive trauma such as seen in athletes and in military recruits. stress fractures are usually diagnosed late due to non-specific symptomatology and lack of specific physical findings.<sup>[16]</sup> Torg JS et al have reported that due to non-specific symptomatology and paucity of physical signs the average delay in the diagnosis is approximately 7 months or even more.<sup>[17]</sup>

In our study simple undisplaced navicular fractures were found to be most common type of navicular fracture. In various studies avulsion fractures are reported to be the most common type of fractures involving navicular bone. Rosenbaum AJ et al in their review of navicular bone fractures found that almost 50% of the fractures affecting navicular bone are avulsion fractures. Other common causes of fractures include stress fractures and those due to twisting forces as seen in individuals participating in competitive sports.<sup>[18]</sup>

The management of navicular fractures is challenging. Usually the simple undisplaced fractures are treated by use of a weight-bearing short leg cast for six weeks followed by the use of a walking boot for an additional four to six weeks. Clements JR et al have reported that the non-operative treatment has excellent results in cases of avulsion injuries and non-displaced body fractures.<sup>[19]</sup> For other fractures like displaced and comminuted fractures. Common complications in the patients with navicular fractures are reported to

be pain, stiffness, post-traumatic arthritis, avascular necrosis, nonunion, and hindfoot deformity.<sup>[20]</sup>

## CONCLUSION

Tarsal Navicular fractures are frequently due to direct high velocity trauma, twisting injuries as seen during competitive sports and due to repeated minor trauma as seen in stress fractures. The diagnosis is usually done by imaging and management consist of conservative treatment in cases of undisplaced and stress fractures while surgical interventions are required in displaced fractures. Early diagnosis and proper management is associated with good functional outcome in majority of the cases.

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