

# Does the Fracture Morphology, Timing of Intervention Determine the Outcome in Operated Talus Neck and Body Fractures? A Retrospective Analysis of 49 Patients

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## ABSTRACT

**Background:** Talus fractures comprise approximately 0.1–0.85% of all fractures. They usually present following a high-velocity trauma and with soft tissue damage. Our objectives are to study whether the fracture morphology, the timing of intervention, the injury status, and the presence of Hawkin's sign influence the outcomes in operated cases with talus fractures. To test our hypothesis that open talus fractures, talus body fractures with comminution, and the time delay in initiating treatment cause poor results.

**Materials and methods:** It is a retrospective analysis of all operated talus fractures between 2015 and 2019. Of the total 62 patients, 49 patients met our inclusion criteria. Preoperative X-rays and preoperative computed tomography (CT) scans were analyzed. Based on the fracture morphology, cases were divided into groups A (talus neck) and B (talus body). Postoperative assessment for the fracture union, presence of Hawkin's sign, the incidence of avascular necrosis (AVN), rate of infections, and secondary arthritis were noted. The functional outcomes were calculated using the American Orthopaedic Foot and Ankle Society (AOFAS) score.

**Results:** Among 49 patients, 34 talus neck fractures and 15 talus body fractures were assessed. The risk of AVN in talus neck fracture increases with injury severity ( $p$ -value of 0.04). There was no statistical difference between the closed and open talus fractures regarding AVN, infection rate, and secondary arthritis. The mean AOFAS score was 84.9 in group I and 81.8 in group II. Hawkin's sign showed 61.1% reliability for detecting AVN. However, the specificity is limited.

**Conclusion:** The talus neck and body fracture outcome did not vary significantly. The incidence of AVN positively correlated with the increasing severity of the talus neck fracture. According to Sneppen's fracture variants, the sagittal split-type talus body fracture had a marginally better outcome than the coronal split type and crushing-type body fracture with comminution. The rates of infection and AVN between closed and open talus fractures and the initial time delay for surgery did not influence our final results, and there was no statistical difference.

**Keywords:** American Orthopaedic Foot and Ankle Society score, Avascular necrosis of talus, Hawkin's sign, Secondary arthritis, Talus body fracture, Talus neck fracture.

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## INTRODUCTION

The talus fractures comprise approximately 0.1–0.85% of all fractures.<sup>1,2</sup> They usually present following a high-velocity trauma and with soft tissue damage. These fractures are challenging to treat due to their complex anatomy and poor vascularity, leading to avascular necrosis (AVN) and secondary arthritis.<sup>3,4</sup> Based upon the primary fracture line that passes anterior or posterior to the lateral process of the talus, these fractures are classified as talus neck or talus body fractures, respectively. The initial evaluation should be done in the casualty to assess the ankle swelling, open wounds, joint dislocations, and neurovascular insult, and separate foot and ankle radiographs in both anteroposterior (AP) and lateral projections should be taken. The role of a computed tomography (CT) scan is paramount to assess the fracture pattern and differentiate it into a talus neck/body fracture. It also helps to understand the fracture comminution, subtalar/talonavicular displacements, and the presence of intraarticular loose fragments.<sup>5</sup> Our objectives are to study whether the fracture morphology, the timing of intervention, the injury status, and the presence of Hawkin's sign influence the outcomes in operated cases with talus fractures. To

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test our hypothesis that open talus fractures, talus body fractures with comminution, and the time delay in initiating treatment cause poor results.

## MATERIALS AND METHODS

The study was conducted after the Institutional Review Board's approval, and the data was extracted from the hospital software. It was a retrospective analysis of 62 cases of talus fractures operated in the age-group of 18–75 years at our level one tertiary care trauma center year from 2015 to 2019. We included all operated cases of closed and open talus fractures. Complete talus extrusions, mangled foot injuries, pathological talus fractures, and polytrauma patients with systemic injuries were excluded from our study. However, 13 cases were lost to follow-up, and 49 cases with >2 years of follow-up were included in our study. Plain radiographs AP, lateral and oblique views of the foot and ankle, and preoperative CT scans were evaluated. In addition, the demographic details, the mode of injury, the timing of intervention, injury characteristics, and the details of operative procedures performed were collected. The study population was subdivided into 34 talus neck fractures (group I) and 15 talus body fractures (group II). We used Hawkin's classification for talus neck fracture and Sneppen et al. classification for talus body fracture.<sup>6,7</sup> We analyzed the rate of infections in open and closed talus fractures, the incidence of AVN, the time for union, and the significance of Hawkin's sign in follow-up radiographs. Functional outcome was assessed using the American Orthopaedic Foot and Ankle Society (AOFAS) score, and the results were rated as excellent if the score is > 95, good 75–94, fair 51–74, and poor > 50.

## OPERATIVE TECHNIQUE

Group I had 34 talus neck fractures, of which 26 patients were closed and eight were open fractures. Once the swelling had subsided, the closed fractures were operated in a single stage. The open talus neck fractures underwent immediate wound debridement within 6 hours of presentation to the hospital and screw fixation for the talus fractures. Under regional anesthesia, the anteromedial approach exposed the talus neck fracture; we used two 1.8 mm K-wires as "joysticks;" the two fracture ends were reduced under an image intensifier and were temporarily held with K-wires. An additional anterolateral approach was used for fractures with comminution and intraarticular fracture fragments. The loose bony pieces were excised, and autologous bone grafts were packed into the fracture gap for particular cases to aid healing. If the subtalar or talonavicular joints were unstable, additional K-wires were used to transfix the joints. Finally, an ankle-spanning external fixator was applied for high-velocity injuries with associated soft tissue loss after securing the fracture with appropriate screws.

Postoperatively, the patients were immobilized with below-knee plaster and started on nonweight-bearing walking with walker support. After 6 weeks, ankle range of movement exercises and partial weight-bearing walking were created with a pneumatic boot. Total weight-bearing walking was advised after the radiological union between 12 and 16 weeks. The absence of fracture gap and good cortical bridging across the fracture ends indicated fracture union.

## RESULTS

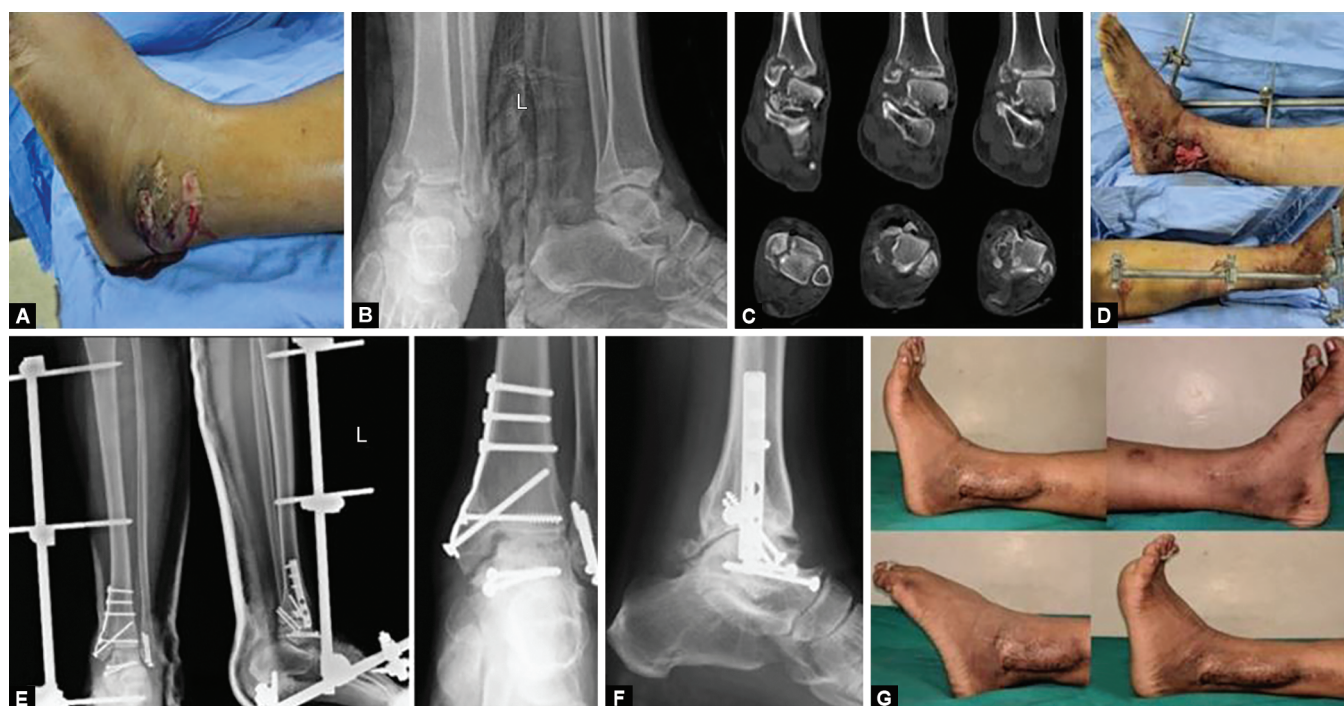
The demographics of the two study populations are presented in Table 1. Of group I's 34 talus neck fractures, 26 were closed, and eight were open fractures. There were 33 males and one female in the study population, with a mean age of 35.6 years. Based on Hawkin's classification, we had 17 cases with type 2, seven patients with type 3, and 10 cases with type 4 fractures. The most typical

**Table 1:** Patient demographics

Variables	Talus neck fractures (34)	Talus body fractures (15)
Classification	Hawkin's types Type 2 - 17 Type 3 - 07 Type 4 - 10	Sneppen's classification types A. Compression - 0 B. Coronal split - 3 C. Sagittal split - 5 D. Posterior - 2 E. Lateral - 0 F. Crush type - 5
Males: Females	33:1	13:2
Mean Age in years	35.6 (23 to 68)	32.6 (19 to 75)
Mode of Injury		
Road Traffic Accident	24	6
Fall from height	08	6
Sports Injuries	02	3
Mean Time delay for surgery	3.5 (1 to 14 days)	5.5 (1 to 16 days)
Closed injuries	26	11
Open injury cases	Total 8	Total 4
Primary skin closure	3	2
Split skin grafting	3	0
Local Flap cover	2	2
Modes of fixation		
Only cancellous screws	27	4
Only Herbert screws	0	7
Cancellous & Herbert screws	6	4
Mini-plate fixation	1	0

mode of injury was a road traffic accident (RTA) in nearly 70% of our study population, followed by fall from height in 22% of the cases and sports-related injuries in 8% of cases. The mean time delay for the surgical intervention was 3.53 days (range one to 14 days). Of the eight open fractures, three patients had primary skin suturing as there was no skin loss, two required second-stage flap cover for the raw area around the ankle, and three required split skin grafting. A total of 27 talus neck fractures were fixed using 4 mm cancellous screws, and in six cases, a combination of 4 mm cancellous screws and 2.4 mm Herbert screws were used. In one patient with severe comminution, mini-plate and screw fixation was done. A case example of an open talus neck fracture in a 42 years male following a fall from a two-wheeler was managed successfully with immediate wound debridement, articular reconstruction, and ankle-spanning external fixator, followed later by a local flap cover (Fig. 1). The mean follow-up period was 21.8 months (12–59 months). Union was achieved in all the cases, at an average duration of 16.5 weeks (12–20 weeks). The mean AOFAS score was  $84.9 \pm 7.29$ . Four patients achieved excellent outcomes, 29 had good outcomes, and one had a fair result at the end of 2 years.

Group II consisted of 15 talus body fractures, of which 11 patients had closed fractures, and four had open fractures. There were 13 males and two females. The mean age of the patient population was 32.6 years. The most common mode of injury was motor vehicle crash (40%) and fall from height (40%), followed by twisting injuries in 20% of the cases. Based upon the primary fracture line in CT, we subdivided the body fractures into a coronal



**Figs 1A to G:** A 24-year-old male fell from a two-wheeler presented within 6 hours after injury. (A) Open wound ankle; (B) Preoperative X-ray showing medial malleolus and talus neck fracture; (C) Preoperative CT scan; (D) Intraoperative wound images; (E) Immediate postoperative X-ray; (F) 24 months follow-up X-ray; (G) Final functional outcome

split in three cases, a sagittal break in five instances, crush fractures with comminution in five cases, and posterior tubercle fractures in two cases. The average time interval from presentation to surgery was 5.5 days (1–16 days). Two patients had primary closure of the open fracture wound, while two patients required local flap cover. All patients underwent open reduction and fixation using Herbert screws or 4 mm cancellous screws under image intensifier guidance (Fig. 2). The mean time for fracture union was 18.2 weeks (14–24 weeks). The average AOFAS score was  $81.8 \pm 6.66$ . One patient had an excellent outcome, 11 patients had a good outcome, and three patients had a fair outcome.

## COMPLICATIONS

Avascular necrosis (AVN) was commonly seen in 45% of the study population. Four patients had a superficial surgical site infection, which settled with antibiotics, while one patient had a deep-seated infection, which needed surgical intervention. There was no wound healing problem in the closed fractures. Seven patients underwent a secondary procedure—five patients had implant removal, while two patients underwent arthrodesis for secondary arthritis.

In group I, we had four cases of wound infection—three were superficial, and one was a deep surgical site infection. The three patients with superficial infections were treated with intravenous antibiotics based on the wound cultures for 1 week, followed by oral antibiotics for 1 more week. One patient with deep infection required re-debridement and the application of antibiotic beads. Later, once the infection was quiescent, ankle arthrodesis was done. Then 2 years of postsurgery, 17 out of

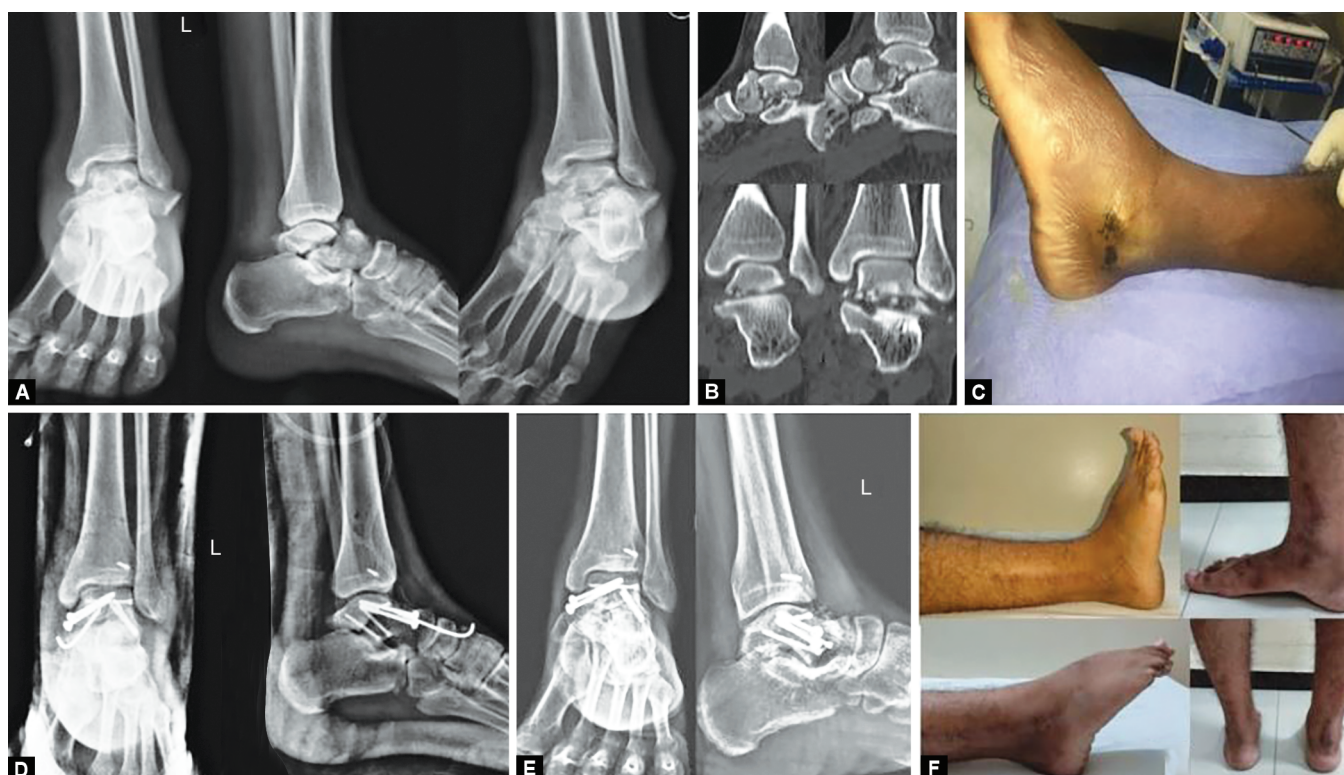
34 cases (50%) had radiological signs of AVN. However, these patients were not symptomatic and could do their routine work with slight discomfort.

In group II, only one patient had a superficial wound infection that subsided with appropriate antibiotics. Seven patients out of the 15 talus body fractures had features of AVN. Painful secondary arthritis of the ankle was seen in one patient who underwent ankle and subtalar arthrodesis (Fig. 3).

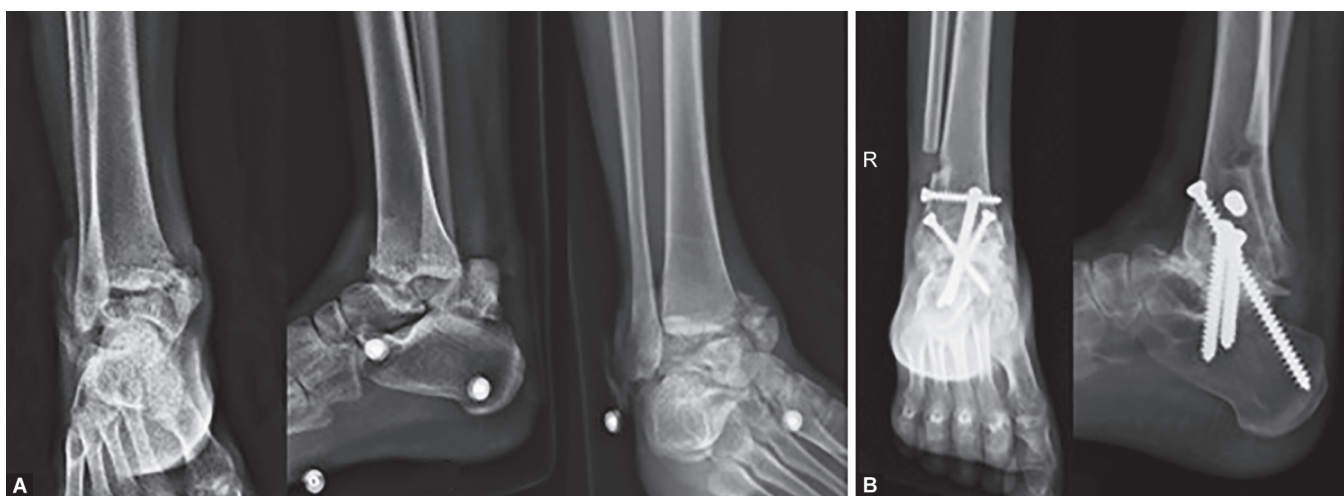
We did a subgroup analysis to correlate the functional outcome and incidence of complications with the associated factors like fracture morphology, soft tissue status, and timing of surgery. The incidence of AVN increased with the grading of talar neck fractures, which was statistically significant ( $p$ -value of 0.04). However, the functional outcome and incidence of infection did not significantly vary between the various grades of neck fractures (Table 2).

Open and closed fractures did not show a statistically significant difference in functional outcome and incidence of complications like AVN, arthritis, and infection in both groups (Tables 3 and 4). There was also no significant difference in the outcome between talus neck and body fractures, although the mean functional score was slightly higher in the talus neck fracture group (Table 5). The relation between the functional outcome and the talus body fracture morphology was assessed (Table 6). The mean value was better in the sagittal split type, which was statistically significant ( $p$ -value of 0.04).

The time delay between injury and surgery had no bearing on the incidence of AVN (Table 7). Around 61.1% of patients with Hawkins's signs had no AVN during follow-up radiographs ( $p$ -value of 0.169).



**Figs 2A to F:** A 36-year-old male fell from 10 feet height at the workplace. (A) Preoperative X-ray; (B) Preoperative CT showing talus body fracture with comminution; (C) Wrinkle sign; (D) Immediate postoperative X-ray; (E) 30 months follow-up X-ray; (F) Final functional outcome



**Figs 3A and B:** A 55-year-old male with comminuted talus body fracture treated with open reduction and Herbert screws developed talus body collapse and ankle arthritis after 12 months. (A) Preoperative X-rays of displaced talus body fracture; (B) AVN of talus requiring ankle fusion

## DISCUSSION

Biz et al. reported that 70% of the patients in their study group had a completely satisfactory result.<sup>8</sup> Although a reliable predictor of AVN, various studies have shown that Hawkins's sign had a low specificity.<sup>9</sup> Consistent with these observations, 18 patients with talus neck fractures in our series had a positive Hawkins sign, of whom 11 had no signs of AVN. The radiological features suggestive of AVN involving the talus dome were noticed in 17 out of 34 patients in group I and seven out of 15 in group II. However,

the difference between the two groups was not statistically significant. The incidence of AVN was 29.4% in type 2, 57.1% in type 3, and 80% in type 4 talus neck fractures ( $p$ -value of 0.04), which was statistically significant. Thus, the risk of osteonecrosis increases with the severity of the talus neck fractures. Halvorson et al., in their systematic review of the literature on talus neck fractures, concluded a positive association exists between the severity of talus neck fractures based on Hawkins staging and the development of AVN.<sup>10</sup>

**Table 2:** Functional outcome and incidence of complications in talus neck fractures—subdivided based on Hawkins's type

Hawkins's type	AVN and arthritis	Infection	Secondary procedures	AOFAS score
Type 2	5	1	3	86.53
Type 3	4	1	2	85.57
Type 4	8	2	1	81.80
<i>p</i> -values	0.04	0.516	0.717	0.265

**Table 3:** Final outcomes of closed vs open talus neck fractures

Type	AVN and ankle arthritis	Infection	Secondary procedures	AOFAS score
Closed (24)	12	2	4	85.80
Open (10)	5	2	2	84.58
<i>p</i> -value	>0.5	0.564	>0.999	0.641

**Table 4:** Final outcome of talus body fractures

Type	AVN and ankle arthritis	Infection	Secondary procedures	AOFAS score
Closed (11)	6	0	1	83.64
Open (4)	1	1	0	78.25
<i>p</i> -value	0.566	0.267	>0.999	0.502

**Table 5:** Comparison of talus neck and talus body fracture outcomes

Type	Total number	AOFAS score	AVN and secondary arthritis	Infection	Secondary procedures
Talus neck fractures	34	84.9	17	4	6
Talus body fractures	15	81.8	7	1	1
<i>p</i> -value		0.08	1.0	1.0	0.41

**Table 6:** Comparison of the functional outcome in the various types of body fractures

Sneppen's type	Total number	Mean AOFAS score
Coronal split	3	79
Sagittal split	5	87
Crush	5	78
Posterior	2	81
<i>p</i> -values		0.04

**Table 7:** Correlation between the timing of surgical intervention and development of AVN

Type	AVN when operated < 7 days	AVN when operated > 7 days	<i>p</i> -value
Talus neck fractures	14/28	3/6	1.0
Talus body fractures	4/9	3/6	1.0

Kopp et al. 2013 reported on 56 talus fractures and concluded that staged treatment is effective in patients with acute talus dislocations and open talus fractures.<sup>11</sup> An increased surgery waiting period did not influence our series's functional outcome.

Vallier et al. noted that in about 8% of their study, patients with early superficial infection settled with oral antibiotics, and the fracture healed well.<sup>12</sup> McKeever et al. concluded that open injuries were more likely to develop a disease in talus neck fractures.<sup>13</sup> In group I, we had three patients with a superficial infection that subsided with intravenous antibiotics and one with a deep infection that needed wound debridement and antibiotic pellets. However, the difference in infection rate between open and closed talus fractures was not statistically significant (*p*-value of 0.564). Our findings contradicted those of Liu et al., who reported an infection rate of 41% in open fractures.<sup>14</sup>

Sen et al. stated that complications after fixation of the talus body fracture are inevitable, especially with the displaced shearing

and the crush-type talus body fractures.<sup>15</sup> The development of ankle and subtalar arthritis is the most common posttraumatic sequelae of talar neck and body fractures.<sup>16,17</sup> In our study, we found 41.2% (14 patients) in group I and 40% (six patients) developed secondary arthritis in the talus body group. This arthritis may be related to initial cartilage injury or altered biomechanics of the ankle and subtalar joints during fracture consolidation. Patients with mild to moderate arthritis should be treated conservatively through lifestyle modification and physiotherapy rehabilitation. Gomes de Sousa et al. found that AVN and posttraumatic arthritis were present in half of the patients with talus fractures. They stated that the osteonecrosis of the talus body was inevitable despite sound anatomical reduction and stable fixation.<sup>18</sup> Arthrodesis and fusion should be reserved for patients with debilitating arthritis and failed conservative therapy and should also be considered a primary mode of management in patients with severely comminuted fractures, which could be reduced.<sup>19</sup> Only a small subset of patients in our series with painful ankle arthritis required tibiotalar fusion.

One in groups I and II required ankle fusion after failed conservative therapy due to AVN and secondary arthritis.

There was no statistically significant difference between talus neck and body fractures regarding functional outcome and incidence of complications. Wijers et al. believed that functional outcome is more dependent on factors like comminution and amount of displacement rather than the location of the fracture line.<sup>20</sup> The study's strength is assessing the functional outcome using a validated score and radiographic evaluation. The limitations include the retrospective nature of the study, a small study population, and a short follow-up period. Randomized trials with larger groups and long-term follow-up will identify late complications and possible risk factors. Our study was proposed and accepted by our institutional review board. We received no external funding for our research and no financial disclosures.

## CONCLUSION

The incidence of AVN positively correlated with the increasing severity of the talus neck fracture. Sagittal split-type morphology had a better functional outcome among talus body fractures than the other variants. The infection and AVN rates did not vary significantly between closed and open talus fractures. An initial delay in surgery was not associated with an increased incidence of complications or poor functional outcomes.

## DECLARATION

The authors declare that there were no conflicts of interest, and no external funding was obtained for the study.

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