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Midterm Outcomes after Operative Management of Hawkins Type III Talar Neck Fractures

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Background: This study aims to report the midterm outcomes after surgical treatment of Hawkins Classification III Talar neck fractures.

Methods: From March 2010 to April 2022, among a total of 155 patients who visited our hospital with talus fractures, 31 patients underwent surgical treatment for Hawkins classification III talar neck fractures. The inclusion criteria comprised patients with a symptom duration of over 1 year who were available for outpatient follow-up and underwent magnetic resonance imaging (MRI) follow-up 2 months after surgery. Exclusion criteria included patients without preoperative ankle periarticular arthritis, and a total of 27 patients were enrolled. Traffic accidents and falls accounted for 86% of 23 cases, open fractures were 8 cases, and the mean follow-up period was 34.10 months (range, 12–80 months). Clinical outcomes were measured by American Orthopaedic Foot and Ankle Society (AOFAS) score and Foot function index (FFI), and radiological results were obtained using simple radiographs before and after surgery and MRI at 2 months postoperatively to confirm bone union and complications.

Results: Complete bone union was achieved in all cases, and the mean duration of union was 4.9 months (range, 4–6 months) and there were no nonunion and varus malunion. At the final follow-up, the mean AOFAS score was 80.18 points (range, 36–90 points) and the mean FFI score was 31.43 points (range, 10–68 points), showing relatively good clinical outcomes. There were 15 cases of avascular necrosis, 6 cases of traumatic arthritis of the ankle joint, 6 cases of irritation of the posterior tibial nerve, and 4 cases of wound problems.

Conclusions: Hawkins classification III talar neck fractures are mostly caused by high-energy injuries and have a relatively poor prognosis due to the high incidence of complications such as avascular necrosis or posttraumatic arthritis. However, if correct anatomical reduction and rigid internal fixation are performed within a short time after the injury, good results can be expected.

Keywords: *Talar neck fracture, Hawkins classification III, Midterm outcomes*

The most common mechanism of talus neck fractures is known to be excessive dorsiflexion of the foot with respect to the tibia. It is often caused by traffic accidents or falls, and the classification system proposed by Hawkins in 1970 is widely used as an important guideline for treatment and prognosis prediction. Type I is a fracture without displacement, type II is a displaced fracture with subluxation or dislocation of the subtalar joint, type III is a type where not only the subtalar joint but also the tibiotalar joint is dislocated, and type IV is very rare and involves subluxation or dislocation of the talonavicular joint in addition to type III injury.[1,2] Since there are significant variations in the stress applied to the anterior and middle joint surfaces

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of the subtalar joint in these fractures, precise reduction and fixation are crucial in treatment. If accurate reduction and fixation are performed surgically, even if there is avascular necrosis in some parts of the talus body, good results can be expected in the majority of cases.[3,4] However, complications such as avascular necrosis, nonunion, and articular cartilage damage can occur even with surgical treatment and may lead to nonunion, osteonecrosis, and joint degeneration.[5] Avascular necrosis is the most common complication, and the affected area where avascular necrosis occurs appears relatively sclerotic on radiographic findings because bone resorption does not occur. Even if avascular necrosis does not occur, traumatic arthritis can occur due to cartilage damage at the time of injury, especially in the subtalar joint.[6,7]

Talar neck fractures accompanied by dislocation are associated with a high complication rate, and various studies have reported an increased complication rate with higher Hawkins types and more severe initial fracture patterns.[8] Particularly, damage to soft tissues caused by the dislocated bone fragment leads to a higher complication rate, emphasizing the need for prompt surgical intervention to minimize such damage. Accurate anatomical reduction and rigid internal fixation are essential, and this is often technically challenging.[9,10] Research results regarding the midterm outcomes following surgical treatment for such cases are rare. In cases of Hawkins type I and II fractures that presented to our clinic, surgical intervention was generally not required, and in most cases, reduction and fixation could be achieved without significant manipulation. Additionally, Hawkins type IV fractures were extremely rare, making them unsuitable for comparison. Therefore, we aimed to report the clinical and radiological outcomes of patients who underwent surgical treatment for Hawkins type III fractures of the talus.

METHODS

This study was conducted retrospectively with approval of the Institutional Review Board of Chosun University Hospital (IRB No. 2022-08-028). In addition, the requirement for informed consent was waived.

From March 2010 to April 2022, a total of 155 patients who presented to our hospital with talus fractures were included in the study. Among them, 31 patients underwent surgical treatment for Hawkins type III talar neck fractures. The inclusion criteria comprised patients with a symptom duration of over 1 year who were available for outpatient follow-up and underwent magnetic resonance imaging (MRI) follow-up 2 months after surgery. Exclusion criteria included patients without preoperative ankle periarticular arthritis, and a total of 27 patients were enrolled. The mean age of the patients in the study group was 41.18 years (range,16–68 years). There were 23 male patients and 4 female patients. The leading causes of injury were high-energy mechanisms, with traffic accidents and falls accounting for 23 cases, representing 86% of the cases. Approximately 70% of the cases (19/27) involved comminuted fractures. Open fractures were observed in 8 cases (Gustilo-Anderson classification I: 2, II: 3, IIIA: 3) that were eligible for soft-tissue coverage. For all open fracture cases, surgery was performed in a 1-stage operation. After thorough massive irrigation, fixation was achieved using screws without the use of plates, followed by primary wound closure. Excluding patients transferred from other hospitals or those with severely unstable vital signs due to multiple trauma, emergency surgery was performed within 24 hours of admission. The average time from injury to surgery was 0.89 days and the average follow-up period was 34.10 months (range, 12–80 months) (Table 1).

Before surgery, the Hawkins type was determined by assessing the degree of displacement of the fracture fragment and the presence of adjacent joint dislocation through simple radiographs and computed tomography scans. An attempt was made to achieve anatomical reduction of the dislocated joint surface whenever possible. Regardless of whether anatomical reduction was achieved or not, the general principle was to perform emergency

Table 1. Patient Demographics

Variable	Value
Total patient	27
Age (yr)	41.2 (16–68)
Sex (male : female)	23 (85) : 4 (15)
Cause	
Traffic accident	12 (45)
Fall	11 (41)
Slip down	2 (7)
Other	2 (7)
Open fracture	8 (30)
Comminution	19 (70)
Preoperative period (day)	0.89
Follow-up period (mo)	34.10 (12–80)

Values are presented as mean (range) or number (%).

surgery on the same day under either general or spinal anesthesia. The patient was placed in a supine position, and an anterior approach was used by palpating the tibialis anterior tendon to gain access between the tibialis anterior and tibialis posterior tendons to open the joint capsule. Internal fixation was carried out using an interfragmentary distractor (Large distractor, Synthes) after exposing the fractured area (Fig. 1). For visibly displaced fracture fragments, reduction was performed, and the reduction was confirmed to be satisfactory using an image intensifier. Temporary fixation was achieved using 2–3 Kirschner wires. Subsequently, internal fixation was performed using 2.0-mm/2.4-mm small locking compression plates (2.0-mm/2.4-mm locking compression plate, compact hand/compact foot; Synthes), 4.0-mm cannulated screws (Solco), and headless compression screws (Headless Compression Screw, Zimmer Biomet). For patients who underwent medial malleolar osteotomy, before performing osteotomy, drilling was conducted to prepare the area, and then 4.0-mm cannulated screws were used to secure the fragments in place.

Postoperatively, a splint was applied and maintained for fixation and wound care for up to 2 weeks. After that, a cast was applied for up to 6 weeks, and non-weight-bearing crutch walking was maintained. Subsequently, for a period of 4 weeks, a CAM walker brace was worn to support partial weight-bearing ambulation. Considering the improvement in the patient's clinical symptoms, the brace was removed, and a gradual transition to full weight-bearing ambulation was initiated

The internal fixation methods used during surgery included 4.0-mm cannulated screws in 9 cases, 2.0-mm/2.4-mm small locking compression plates in 8 cases, headless compression screws in 4 cases, and a combined approach in 6 cases. Clinical outcomes were assessed using the American Orthopaedic Foot and Ankle Society (AOFAS) score and the foot function index (FFI). Radiological outcomes were evaluated to determine bone union, the presence of avascular necrosis, posttraumatic arthritis, and other factors. To assess avascular necrosis, MRI was performed 2 months after surgery, followed by serial x-rays to determine the collapse of the talar dome and the presence of symptoms in the subsequent period. Additionally, for posttraumatic arthritis evaluation, x-ray follow-ups were performed at 2 months after surgery with monthly intervals, and at 4 months, 6 months, and 1 year after surgery for comparison. The final diagnosis was made based on x-ray evidence of osteoarthritis changes until the last follow-up. Complications observed included avascular necrosis, posttraumatic arthritis, posterior tibial nerve irritation symptoms, and wound problems.

The collected data were analyzed using the IBM SPSS version 26.0 statistical software program (IBM Corp.). Statistical analyses were performed using the chi-square test and independent samples *t*-test. A significance level (*p*-value) of less than or equal to 0.05 was considered statistically significant.

RESULTS

In the previous cases, complete bone union was achieved, with an average union period of 4.9 months (range, 4–6 months), and there were no cases of nonunion or malunion. At the final follow-up, the AOFAS score averaged 80.18 points (range, 36–90 points), and the FFI score averaged 31.43 points (range, 10–68 points), indicating relatively favorable clinical outcomes. Avascular necrosis (Fig. 2) occurred in 15 cases (55%), while posttraumatic arthritis (Fig. 3) occurred in 6 cases (22%). Symptoms of posterior tibial nerve irritation were observed in 6 cases (22%), and wound problems occurred in 4 cases (15%) (Table 2).

In the comparison of radiological outcomes based

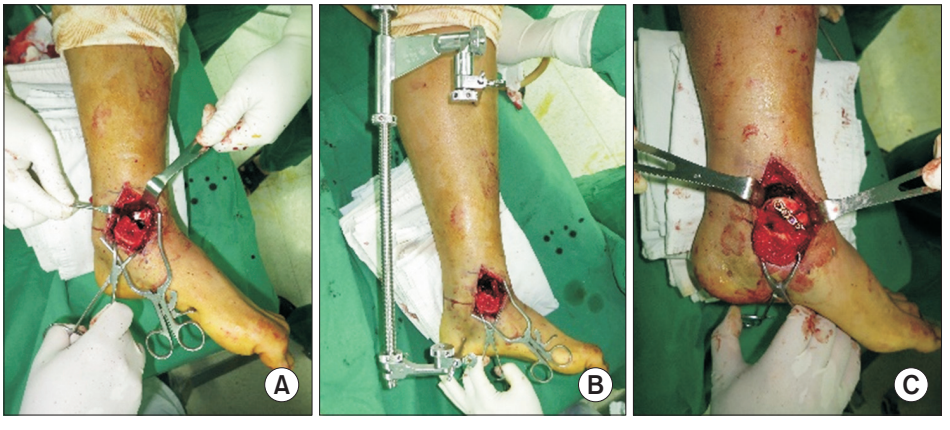

Fig. 1. Intraoperative images showing medial malleolar osteotomy (A) where a large distractor was used for ankle distraction (B), along with fixation using a miniplate on the superior aspect of the deltoid ligament attachment site (C).

on the internal fixation method used during surgery, there was no statistically significant difference in the occurrence of avascular necrosis ($p = 0.254$) or posttraumatic arthritis ($p = 0.357$). Similarly, there were no statistically significant differences in clinical outcomes, as indicated by the AOFAS score ($p = 0.588$) and FFI ($p = 0.461$) (Fig. 4). Furthermore, in the comparison based on the presence or absence of fracture type, avascular necrosis was observed in 3 cases of open fractures and 12 cases of closed fractures ($p = 0.184$), and posttraumatic arthritis was found in 4 cases of open fractures and 2 cases of closed fractures ($p = 0.334$), showing no statistically significant differences (Fig. 5).

In the comparison based on the presence or absence of comminution, avascular necrosis occurred in 11 cases of comminuted fractures and 4 cases of noncomminuted fractures ($p = 0.629$), and posttraumatic arthritis was observed in 4 cases of comminuted fractures and 2 cases of closed fractures ($p = 0.991$), with no statistically significant differences (Fig. 6).

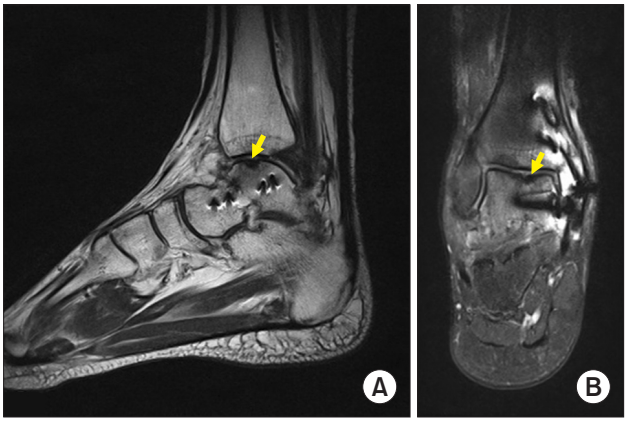

Fig. 2. A 31-year-old man who sustained a Hawkin's type III talar neck fracture in a traffic accident. (A, B) Magnetic resonance imaging taken 2 months after surgery shows evidence of avascular necrosis in the talar dome (yellow arrows).

DISCUSSION

Talar neck fractures often result from high-energy trauma and are frequently associated with displacement and comminution, causing severe soft-tissue damage.[9] Additionally, due to the anatomical characteristics of the

Table 2. The Results of Clinical Assessment

Variable	Value
AOFAS hindfoot scale	80.2 (36–90)
Foot function index	31.4 (10–68)
Complication	
Avascular necrosis	15 (55)
Posttraumatic OA	6 (22)
Posterior tibial nerve symptom	6 (22)
Bone union period (mo)	4.9
Surgical option	
Cannulated screw	9 (33)
Miniplate	8 (30)
Herbert screw	4 (15)
Combined	6 (22)

Values are presented as mean (range) or number (%).
AOFAS: American Orthopaedic Foot and Ankle Society, OA: osteoarthritis.

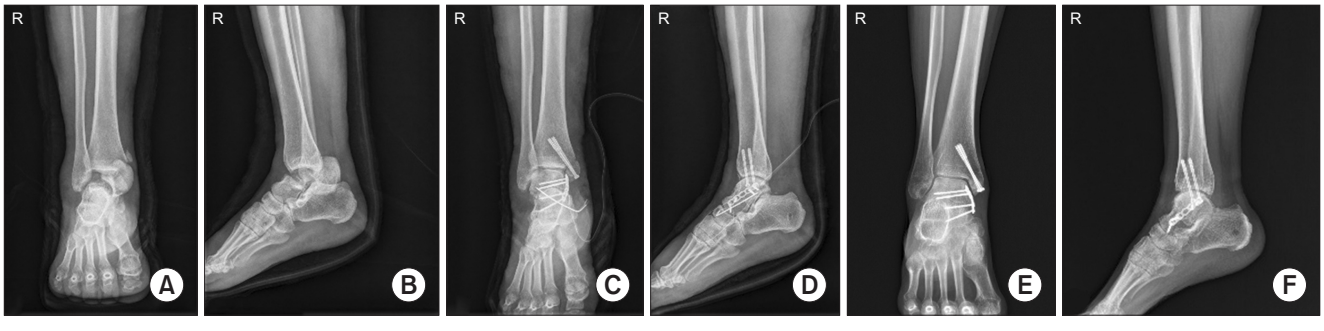

Fig. 3. A 48-year-old woman who sustained a Hawkin's type III talar neck fracture with associated tibiotalar and subtalar dislocations in a traffic accident. (A, B) Preoperative anteroposterior and lateral radiographs. (C, D) Postoperative anteroposterior and lateral radiographs. Emergency surgery was performed on the same day, and open reduction was carried out through a single approach (anteromedial). Medial malleolar osteotomy was performed, and the fracture site was identified using a large distractor. Subsequently, internal fixation was conducted using a miniplate. (E, F) Anteroposterior and lateral radiographs at 1 year postoperatively, Complete bone union was observed, and posttraumatic osteoarthritis was observed in the subtalar joint, characterized by joint space narrowing, sclerotic changes, and the presence of osteophytes.

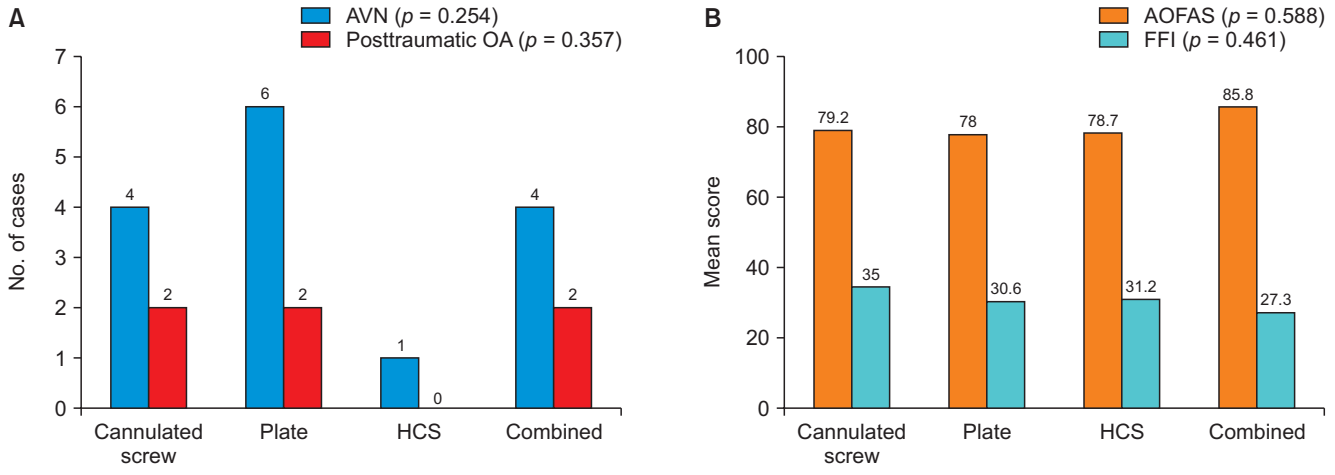

Fig. 4. Comparison of results according to internal fixation method. (A) Complications. (B) Clinical outcomes. AVN: avascular necrosis, OA: osteoarthritis, HCS: headless compression screw, AOFAS: American Orthopaedic Foot and Ankle Society, FFI: foot function index.

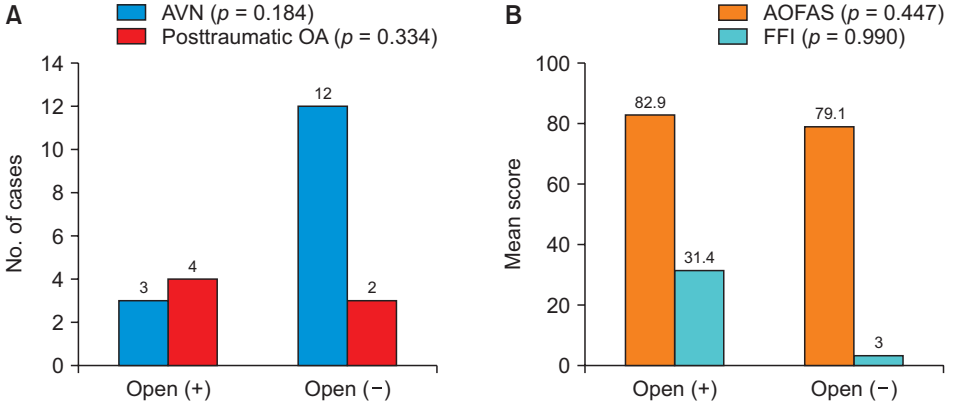

Fig. 5. Comparison of results with/without open fractures. (A) Complications. (B) Clinical outcomes. AVN: avascular necrosis, OA: osteoarthritis, AOFAS: American Orthopaedic Foot and Ankle Society, FFI: foot function index.

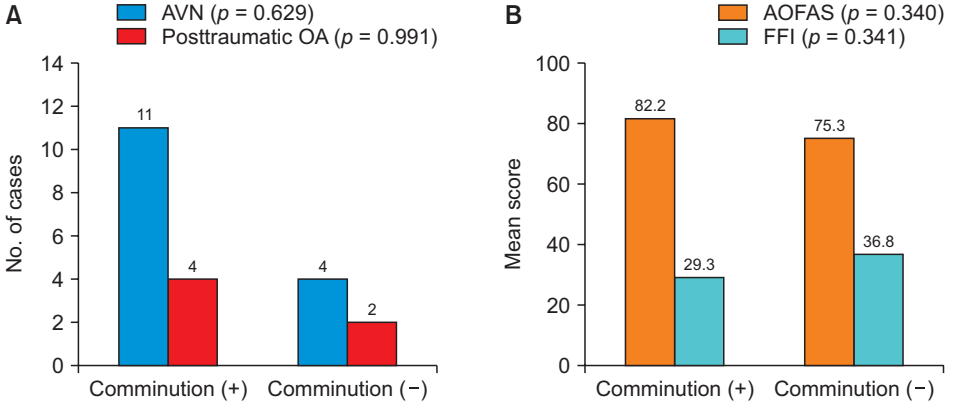

Fig. 6. Comparison of results with/without comminuted fractures. (A) Complications. (B) Clinical outcomes.

talus, where 60%–70% of it consists of joint surfaces with limited blood supply, vascular compromise is common. The majority of blood vessels in the talus run retrograde from the head to the body direction, further impairing blood circulation in cases of fracture.[11,12] These factors contribute to a high incidence of early complications such as skin necrosis, wound dehiscence, and infection, as well as late complications including nonunion, avascular necrosis, and posttraumatic arthritis. Consequently, talar neck fractures are associated with a generally unfavorable prognosis. The treatment principles for displaced talar neck fractures involve achieving anatomical reduction

of the displaced fracture fragments and the surrounding joint surfaces, as well as providing a stable internal fixation that allows for early mobilization to minimize complications.[9,10] In our study, the primary goal was to perform surgery as soon as possible, with a mean time of 0.89 days from the time of injury to surgical intervention, following the principle of emergency surgery on the same day. Early complications related to soft-tissue problems occurred in 4 cases (14%), but these cases were amenable to natural healing without requiring additional surgical procedures. Regarding late complications, avascular necrosis occurred in 15 cases (55%), and posttraumatic arthritis occurred in 6 cases (22%), which is consistent with the results reported in previous studies. Among the patients who developed posttraumatic arthritis, there were no cases requiring additional procedures such as joint fusion surgery, and satisfactory results were achieved. It is worth noting that the relatively young average age of the patients (mean, 41.18 years; range, 16–68 years) and the absence of prolonged immobilization likely contributed to the favorable results. Long-term follow-up and continuous monitoring may still be necessary for this patient population.

Surgical approaches commonly used for displaced talar neck fractures include anteromedial and anterolateral approaches. Depending on the type and location of the fracture, either of these approaches can be used independently or in combination. In most cases, the anteromedial approach is the preferred choice as it provides easier exposure of the fracture site. However, in cases of comminuted fractures, it may be challenging to achieve anatomical reduction using a single approach, leading to the use of a combination of both approaches. It is important to note that the simultaneous use of both approaches can lead to increased soft-tissue dissection on the lateral aspect of the talus, potentially causing vascular compromise in talar neck.[12,13] In our study, all 28 cases were treated using the anteromedial approach exclusively, aiming to minimize soft-tissue damage. Emergency surgery on the same day was performed whenever possible to mitigate complications. Although 4 cases experienced wound problems, they did not require invasive interventions and were able to heal naturally.

The choice of internal fixation method in talar neck fractures should be tailored to the specific fracture type and degree of comminution. In this study, the surgical treatment included the following internal fixation methods: 4.0-mm cannulated screws in 9 cases (33%), 2.0-mm/2.4-mm small locking compression plates in 8 cases (30%), headless compression screws in 4 cases (15%), and the use of 2 or more types of internal fixation devices in 6 cases (22%). In all cases, complete bony union was achieved, and there were no statistically significant differences observed in both radiological and clinical outcomes.

It is well known that complications such as avascular necrosis and posttraumatic arthritis are common in talar neck fractures, and their frequency tends to increase with higher Hawkins types.[14,15] Avascular necrosis, in particular, is known to occur at a higher rate in Hawkins type III talar neck fractures. Previous studies have reported a 44.7% occurrence rate by Halvorson et al.[16] and a 55.0% occurrence rate by Jordan et al.[5] In our study, all patients underwent postoperative MRI scans at 2 months after surgery to monitor the occurrence of avascular necrosis. It was observed in 15 cases (55%), which is consistent with previous reports. Regarding posttraumatic arthritis, it occurred in 6 cases (22%) in this study, which is lower than the rates reported in some previous studies: Vallier et al.[9] reported a 33% occurrence rate, and Jordan et al.[5] reported a 54.24% occurrence rate. It is noteworthy that even in cases where avascular necrosis or posttraumatic arthritis occurred, most patients remained asymptomatic, and there was no need for additional surgery such as joint fusion. Clinical indicators also showed favorable outcomes, with an average AOFAS score of 78.06 and FFI score of 32.06.

This study has several limitations that should be acknowledged. Firstly, the sample size is relatively small, and the study design is retrospective. Additionally, when comparing different fixation methods, there was a lack of consideration for patient demographics, and the clinical outcomes were primarily assessed through patient satisfaction indicators such as AOFAS scores and FFI. Therefore, future research should focus on collecting additional cases and conducting longer-term follow-up observations to provide more comprehensive and objective data.

Hawkins type III talar neck fractures, typically caused by high-energy trauma, are associated with a relatively poor prognosis due to a high incidence of complications such as avascular necrosis and posttraumatic arthritis. However, it is believed that with prompt reduction and appropriate surgical approaches performed shortly after the injury, achieving accurate anatomical reduction and stable internal fixation can lead to favorable outcomes.

CONFLICT OF INTEREST

No potential conflict of interest relevant to this article was reported.

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