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HAWKINS SIGN'S PROGNOSTIC RELIABILITY IN FRACTURES OF TALUS

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Abstract

Background

The Talus is a unique bone which has tenuous blood supply and articular cartilage covering 57% of its surface. Fracture of the neck, head or body of talus has increased chances to impair its blood supply resulting in Avascular Necrosis(AVN). AVN of the talus can result in severe disability. Many causes exist that can cause talar AVN, with the most common being talus neck fractures. Patients usually present with ankle pain and limited rom of ankle joint. This study was done to evaluate the prognostic reliability Hawkins sign. The Hawkins sign is a radiolucent band in subchondral region over the dome of talus bone, it emerges as an important early indicator of talus viability at 6 to 8 weeks post fracture which is seen in xray ankle AP view and rarely appears on lateral view.

Materials And Methods: This is a prospective study conducted at Saveetha Medical College hospital and included patients treated for displaced talar fractures from January 2023 to December 2023. The study focused on 21 patients who were followed up for 12 months. Reliability of the Hawkins sign and its prognosis was analysed in 21 patients.

Result: 11 patients had positive Hawkins sign, 2 had partially positive and 8 had negative sign with all 8 patients with negative sign developing AVN. Hawkins sign occurred earliest at 6^{th} week and latest at 9^{th} week

Conclusion: The Hawkins sign is a valuable prognostic tool for assessing talus vascularity after fractures. A positive Hawkins sign indicates a favourable prognosis regarding the development of AVN. However negative Hawkins sign does not conclusively predict Avascular Necrosis, necessitating further investigation and monitoring in such cases.

Keywords: Avascular Necrosis, Hawkins sign, talar dome, subchondral radiolucent band

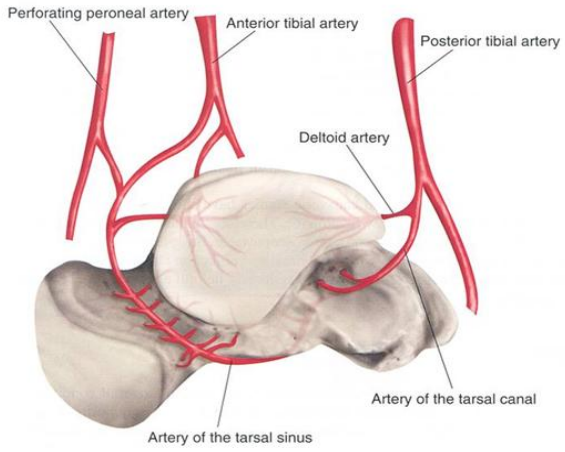
INTRODUCTION

The talus is the second largest of the tarsal bones and has a unique structure designed to channel and distribute body weight. Approximately 60% of its surface is covered by articular cartilage, and there are no muscular or tendinous attachments to this bone. Therefore, only a limited area of area of penetrable bone is available for vascular perforation.Along with this, small nutrient vessels, variations in intraosseous anastomoses, and a lack of collateral circulation put talus at risk for avascular necrosis when its blood supply is disturbed.Talus consists of body, neck, and head, articulating with the calcaneus inferiorly, the tibia and fibula supralaterally (proximally), and the navicular bone distally**.**

The body of the talus is wider anteriorly than posteriorly. It also includes two bone processes – a lateral process and a posterior process.The posterior process is divided into medial and lateral tubercles by a groove for the flexor hallucis longus tendon.The supralateral and, to a lesser extent, medial cartilaginous surface of the talus extend to articulate with the tibia and fibula.The inferior surface articulates with the posterior facet of the calcaneus, forming a part of the subtalar joint.The neck of the talus is narrow and cylindrical in shape.

Three extraosseous arterial contributors branch to supply the bone: the posterior tibial artery, the dorsalis pedis artery, and the perforating peroneal artery.Posterior tubercle branches arise from the posterior tibial artery and in

combination with branches of the perforating peroneal artery, supply both the medial and lateral tubercles.Beyond this, about 1 cm proximal posterior tibial artery gives rise to the tarsal canal artery.'The tarsal canal artery supplies the central and lateral two-thirds of the talar body.
Deltoid branches arising from this artery supply the remaining medial third of the talar body.Branches of the anterior tibial artery supply the superomedial half of the talar head and neck.The inferolateral half is supplied either directly by the tarsal sinus artery, from branches of the anastomotic "loop" between the tarsal sinus artery and the tarsal canal artery, or from the lateral tarsal artery (a branch of the dorsalis pedis artery).



Development of Avascular necrosis (AVN) of the talus is a grievous complication post trauma, the chances of AVN increases with the displacement and severity of fracture and the damage to its tenuous vascularity(1-3,10-14). The Hawkins sign is a radiolucent band in subchondral region over the dome of talus bone, it emerges as an important early indicator of talus viability following a fracture. In this study we aim to evaluate the reliability of the Hawkins sign in predicting AVN after fracture of talus bone. AVN leads to pain, instability and arthritis of the ankle joint(5,6) , worse functional outcomes, and resurgery(4,7-9).
Apart from posttraumatic causes, it can occasionally have non-traumatic aetiologies ranging from alcoholism, steroid use, dyslipidemia, or an idiopathic cause. The diagnosis of AVN talus can be a challenge, and the surgeon needs to anticipate it, especially in traumatic cases with significantly displaced body fragment. The treatment of AVN talus can also be frustrating and is a major challenge to the surgeon; the results after talus collapse are suboptimal in many cases, even in the best of surgical hands.
The preoperative workup and imaging gives an idea about the aetiology, duration, rate of progression, extent of the AVN, including the stage of the disease, and the degree of disability of the patient.
The various treatment modalities described in literature for treating AVN talus include the following: Nonoperative management (non weight bearing, protected weight bearing using splints such as the patellar tendon brace (PTB), and extracorporeal shock wave therapy (ESWT), (b) Surgical joint-sparing procedures (core decompression, bone grafting – vascularized or non vascularized autografts) (c) Joint sacrificing procedures (partial or total talar replacement (TTR), (d) Salvage procedures (talectomy, arthrodesis of ankle, subtalar, tibionavicular, tibiocalcaneal (TC), or tibiotalocalcaneal joints) (e) Total ankle replacement (TAR)
Literature states that fractures of the talar neck are thought to occur most commonly, accounting for approximately 50% of talus fractures. 20–25% of talus fractures are open injuries. Complications of talus fractures include avascular necrosis (AVN), post-traumatic osteoarthritis (OA), malunion, non-union, infection, joint stiffness and post-traumatic osteoarthritis. These complications often cause chronic pain, difficulties in performing activities of daily living and decreased mobility. The intraosseous blood supply to the talus mainly arises from the dorsalis pedis artery (superomedial) and the artery of the tarsal sinus (inferolateral), whereas the extraosseous blood supply arises from the three main lower limb arteries with associated 'watershed' areas of variable contribution to the talus. The presence of 'watershed' areas can contribute to poor healing after fixation leading to a sequalae of complications such as AVN. Potential complications may be anticipated and managed by meticulous management of open fractures and careful anatomical reduction and fixation of displaced fractures, However, it is important to acknowledge that some fracture patterns are inoperable and unsalvageable.

MATERIALS AND METHODS

This is a prospective study conducted at a Saveetha Medical College hospital and included patients treated for talar fractures from January 2023 to December 2023 in our institute's Orthopedic Department. The study focused on 21 patients who were followed up for 12 months. The Hawkins sign's reliability was analysed in 21 patients with talus fractures.

Diagnosis

Hawkins Sign on AP view

This suggests evidence of revascularization of talar body and is thought to indicate talar viability. It is indicated by

-patchy subchondral osteoporosis at approx 6-8 weeks;

– resorption of subchondral bone

-As in many cases, the blood supply that remains is from the medial side [by branches of deltoid artery], the Hawkin's sign is often seen medially**.**

MRI

MRI shows low signal on T1-weighted images secondary to adipocyte death and a variable signal on T2-weighted images depending on contents of the avascular region. Pathognomonic "double line" sign uncommon.

Bone Scan

It can pick the signs of osteonecrosis at the earliest.

Patient Selection

The study included patients who underwent surgery for displaced talar fractures between January 2023 and December 2023. The patients age in the study ranged from 20 to 60 year, with mean age of 35 years with a 12 month follow up period. We only investigated patients with talus fracture that were operated on. The average follow-up was around 10 months(Range 8-12 months). The study included 14 males and 7 females with talus fractures.

Fractures Classification

These fractures were classified using the Hawkins and Marti/Weber classifications. The majority of fractures were closed, with varying degrees of displacement and involvement of different talar regions. Table 1 presents Hawkins and Marti/Weber classifications of Talus fractures in our patients. Among the 21 patients in our study 17 had closed fractures and 4 had open fractures with 1-grade I and 1-grade II and 2-gradeIIIA injuries.

Table 1: Marti/Weber classification and Hawkins classification of Talus fractures used in our study

Classification	Talar Fracture	n
Marti/Weber		
Type I	Peripheral fractures: processus posterior and processus lateralis-fractures, head and distal fractures of neck	11
Type II	Nondisplaced proximal talar neck or corpus fractures	9
Type III	Dislocated proximal talar neck or corpus fractures	16
Type IV	Proximal talar neck or corpus fractures with total luxation of corpus tali	5
Hawkins		
Peripheral fracture	Peripheral fracture	8
Type I	Nondisplaced talar neck fracture	6
Type II	Talar neck fracture with dislocation in subtalar joint	17
Type III	Talar neck fracture with dislocation in subtalar and ankle joint	7
Type IV	Talar neck fracture with dislocation in subtalar, ankle and talonavicular joint	3

Surgical Approach

Surgeons performed the surgeries using different approaches based on the fracture type and location. The most common was anteromedial approach followed by anterolateral, posterolateral and combined approaches. Fixation

methods included cancellous bone screws and Kirschner wires, with some cases requiring additional measures such as external fixators.

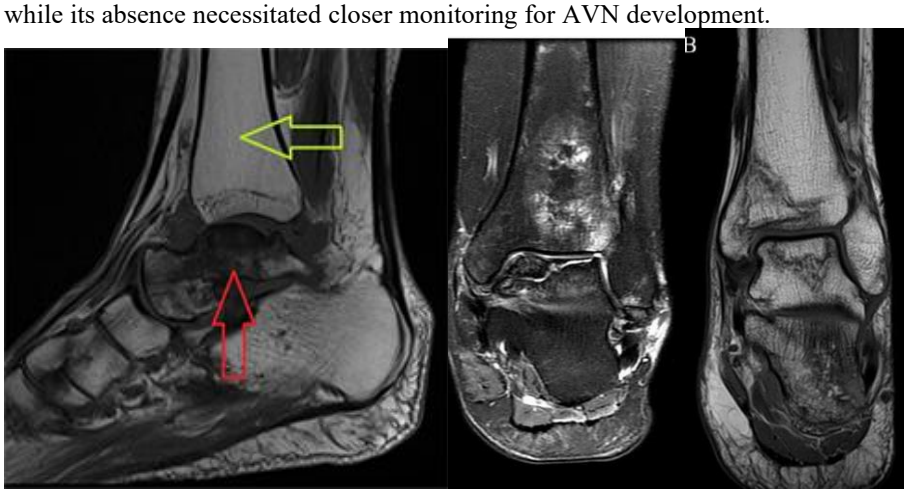
Postoperative Care

Postoperative care included the use of ankle splints and braces, with weight-bearing restrictions tailored to the extent of the fracture and fixation stability. Radiographic evaluations were performed every two weeks to monitor and detect the Hawkins sign.

FINDINGS

Radiological Evaluation

Radiological evaluations focused on detecting the Hawkins sign, assessing reduction accuracy, and identifying AVN. Hawkins sign was evaluated xrays of 21 patients. Positive Hawkins sign indicated a favourable prognosis, while its absence necessitated closer monitoring for AVN development.



Functional Outcomes

Functional outcomes were assessed using the AOFAS Ankle-Hindfoot scale. The scores reflected satisfactory results, with pain and function subscales showing moderate to good recovery. Alignment scores were generally high, indicating successful anatomical restoration in most cases.

Table 2:The Ankle and Hind Foot scale of the American Orthopaedic foot and Ankle society

Subscale	Points
Pain	40
None	40
Mild, occasional	30
Moderate, daily	20
Severe, almost always present	0
Functions	50
Activity limitations, support requirement	
No limitations, no supports	10
No limitation of daily activities	7
Limitation of recreational activities, no support	
Limited daily and recreational activities, cane	4
Severe limitation daily and recreational activities, walker, crutches, wheelchair, brace	0
Maximum walking distance, blocks	
Greater than 6	5
4 to 6	4
1 to 3	2
Less than 1	0
Walking surfaces	
No difficulty on any surface	5
Some difficulty on uneven terrain, stairs,	3
inclines, ladders	0
Gait abnormality	
None, slight	8
Obvious	4
Marked	0
Sagittal motions, (flexion plus extension)	
Normal or mild restriction (30 degrees or more)	8
Moderate restriction (15 to 29 degrees)	4
Severe restriction (less than 15 degrees)	0
Hindfoot motion (inversion plus eversion)	
Normal or mild restriction (75% to 100% normal)	6
Moderate restriction (25% to 75% normal)	3
Marked restriction (less than 25% normal)	0
Ankle-hindfoot stability (anteroposterior, varus-valgus)	
Stable	8
Definitely unstable	0
Alignment (10 points)	
Good, plantigrade foot, ankle-hindfoot well aligned	10
Fair, plantigrade foot, some degree of ankle-hindfoot	5
Malalignment observed, no symptoms	5
Poor, nonplantigrade foot, severe malalignment symptoms	0

Statistical Analysis

The statistical analysis involved calculating sensitivity, specificity, and predictive values of the Hawkins sign. The sensitivity was high at 100%, but the specificity was moderate at 57.7%, highlighting the need for additional diagnostic tools to confirm AVN in patient's with negative Hawkins sign. All statistical analyses were performed using IBM SPSS statistics software (version 24.0).

Results

The 8 patients who had developed AVN had negative Hawkins sign. And in the remaining 13 patients, 11 had positive Hawkins sign, two partially positive(9.4%) sign. The Hawkins sign demonstrated 100% sensitivity with a 57.7% specificity., If the Hawkins sign presented earliest in its 6th to 9th week post surgery and Clinical outcomes were generally satisfactory.

DISCUSSION

People with talar avascular necrosis usually have deep pain in the ankle that comes on gradually. Most people with ankle pain do not have talar avascular necrosis, since it is pretty rare and there are many other causes of ankle pain.

Causes

There are various causes of talar avascular necrosis:

- Trauma: If you have broken your talus bone, whether or not it was treated with surgery, you are more likely to get talar avascular necrosis. This is because the injury may have cut off the blood supply to part of the talus, leading to part of the bone dying. The more severe the injury, the greater the chance of this happening. Usually talar avascular necrosis after a fracture can be diagnosed within one year after the injury, when you are still healing.
- Steroid use: If you have used steroids in high doses or for a long time, you are at increased risk for avascular necrosis. Reasons you might have taken high doses of steroids include treatment of asthma, an autoimmune disease, or cancer.

- Alcohol abuse: If you drink alcohol heavily on a daily basis, you are more likely to get talar avascular necrosis. Drinking heavily increases the amount of fat traveling in your blood vessels. It is thought that drops of fat block small blood vessels, which is what leads to avascular necrosis.
- Blood disorders: Blood disorders associated with clotting of small vessels, such as sickle cell anemia, can lead to talar avascular necrosis.

The Hawkins sign refers to the line of subchondral lucency, first visible between 6 and 8 weeks after the injury and reflecting disuse osteopenia in vascularized bone. It has been considered as a reflector of developing AVN in talus fracture cases, wherein a negative Hawkins sign indicates a high chance of developing AVN. Several authors have studied the prognostic significance of Hawkins sign.

AVN is a grievous complication following fractures of talus bone, significantly associated with fracture severity and fragment displacement. Early prediction of AVN is challenging; however, the Hawkins sign, visible in early radiographs, provides a reliable early indicator of talar viability. Patients with positive/partially positive Hawkins sign has very low chances to develop AVN later. The sensitivity of the Hawkins sign in this study was 100%, but its specificity was lower, indicating that while a positive sign strongly suggests talus viability, a negative sign does not definitively predict AVN.

There are multiple treatment modalities available, varying from nonoperative treatment that works as long as the collapse of talar dome or body could be prevented, to interventions such as core decompression and vascularized grafts that can delay but unfortunately not stop the progression of the disease to collapse and subsequent subtalar and ankle OA. Joint fusions are reserved for the inevitable sequelae of talar body collapse leading to subtalar or ankle OA. Conventional fusion techniques such as Blair's fusion work well in such scenarios. Furthermore, other fusion techniques using retrograde nails or screws are readily available. Modern technology also makes prosthesis available though partial talar replacement has had limited success. TAR is an evolving concept though its effectiveness in the setting of AVN is not conclusive as talar collapse is a hindering issue. One alternative intervention could be fusion of subtalar joint and replacement of the ankle joint. However, conclusive evidence is still not available and further research is warranted for the same. In addition, Hawkins sign appears to be a good prognostic indicator for the treatment of such injuries as it aids in identifying the probability of collapse.

Kubo et al showed that MRI can detect bone necrosis in the early postoperative period; but he followed only 2 cases and did not compare the Hawkins sign with the MRI in determining the function of the ankle follow-up(15) Tezval *et al*. who followed more than 34 patients for 3 years observed that a positive Hawkins sign excludes future AVN (100% sensitivity, 57.7% specificity) and concluded Hawkins sign to be a good indicator of talus vascularity following fracture(16)

The results of the studies of Petersen et al, Schulze et al, Canale and Kelly, and Lutz et al confirm our conclusion(17-20).

RESULTS

To determine the reliability of the Hawkins sign, the plain radiographs were evaluated throughout the course of treatment. The prognostic reliability of the Hawkins sign was studied in 21 patients with talar fractures using the available radiographs, CT scans, and MRI scans. The Hawkins sign was negative in all patients who developed AVN (n = 8). Evaluation of the radiographs of the 13 patients who did not develop AVN resulted in 11 positive, 2 partially positive, and 8 negative Hawkins signs. Thus in our study, the Hawkins sign (if present) occurred at 6 weeks at the earliest and at 9 weeks at the latest time post injury. In cases with a positive or partially positive Hawkins sign, AVN did not develop, whereas in 8 cases with a negative Hawkins sign, a talar AVN was diagnosed. Table 4 shows the 11 patients with negative Hawkins signs who did not develop any AVN (including only one patient with an open fracture). Screw fixation was used in 15 of 21 cases and 4 patient with K-wires. Out of 21 patients 2 patients had developed infection and treated with intravenous antibiotics. These patients were allowed full-weight bearing 8 weeks after the injury. In only one case was it necessary to perform an MRI scan because of chronic ankle joint pain secondary to posttraumatic osteoarthritis.

CONCLUSION

The Hawkins sign is a critical diagnostic tool for evaluating talar fractures. Its presence strongly indicates talus viability, reducing the likelihood of AVN development. However, the absence of the sign warrants further investigation to ensure accurate diagnosis and appropriate management. This study reinforces the value of early radiographic signs in guiding prognosis and treatment strategies for talus fractures.

Declaration
Funding: none
Conflict of interest: none declared
Ethical approval : approval taken from the ethical committee

Table 3: Incidence of Hawkins sign in our study population

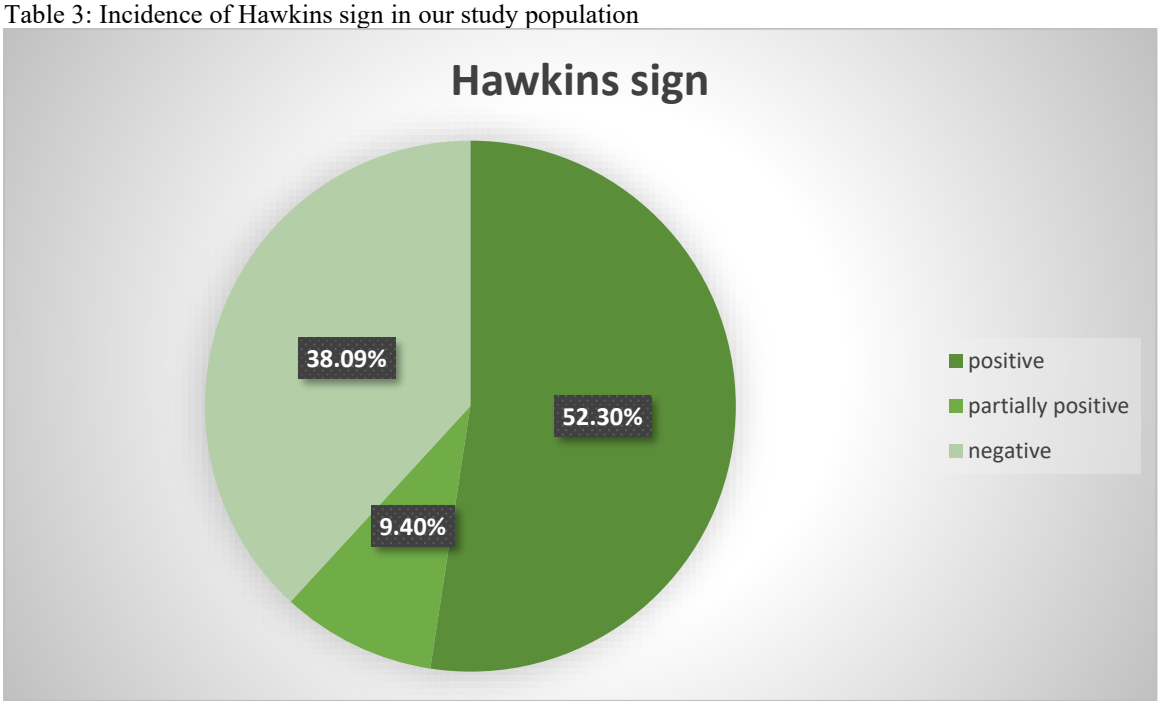


Table 4:

Pt. no	Age/sex	Hawkin' B s classification	Marti/Weber classification	Closed/open fracture	Osteosynthesis	Hawkin's sign
1	29/M	I	II	Closed	Screw	+ve
2	22/M	II	II	Closed	Screw	-ve
3	43/F	Periph.fracture	I	Closed	K-wires	Part+ve
4	31/M	II	II	Closed	Screw	+ve
5	26/M	II	III	Open grade 2	Screw	-ve
6	37/M	I	II	Closed	Screw	+ve
7	25/M	IV	IV	Open grade 3A	Ankle arthrodesis	+ve
8	26/F	Periph.fracture	I	Closed	Screw	+ve
9	34/M	I	II	Closed	K-wires	-ve
10	59/M	II	II	Closed	Screw	-ve
11	35/F	I	I	Closed	Screw	+ve
12	52/F	II	II	Closed	K-wires	+ve
13	28/M	II	III	Open grade 1	Screw	+ve
14	41/F	II	II	Closed	Screw	-ve
15	53/M	II	III	Closed	Screw	-ve
16	34/M	III	III	Closed	Screw	Part+ve
17	29/F	Periph.fracture	I	Closed	K-wires	+ve
18	20/M	III	III	Open grade 3A	Ankle arthrodesis	-ve
19	23/F	I	II	Closed	Screw	+ve
20	42/M	II	II	Closed	Screw	-ve

21	37/F	I	II	Closed	screw	+ve

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