Original Article

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Radiology Section

Radiological study of Os Navicular and its Anatomical variants

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ABSTRACT

Introduction: Accessory ossicles are the skeletal variations of the ankle and foot that can cause painful syndromes. Accessory navicular bone also known as Os Naviculare secundarium, Os tibiale externum, is one of the most common accessory ossicle of the foot with an incidence of 4–21%. The presence of an OSN can trigger various foot problems such as tibialis posterior tendon pathology, flattening of the medial longitudinal arch and medial foot pain.

Aim: To study the incidence, anatomical variants and distribution of Os Navicular (OSN).

Materials and Methods: Accessory navicular bones were retrospectively examined in 1,000 (589 men and 411 women) radiographs of foot in the age group 12-80 years. Anterior-posterior/oblique X-ray images were observed for the presence, anatomical variant, and morphology of OSN. All the data was recorded and analysed.

Results: Out of 1000 radiographs of the foot, 144 cases of OSN were observed with varying shape and size which accounts for 14.4% incidence. All three types of OSN were noted in the present study with Type II being the most predominant variant with incidence of 50%, while Type I with an incidence of 34.72% and Type III with an incidence of 15.27%.

Conclusion: Knowledge regarding the anatomical variants of OSN is important for surgeons and radiologists in the interpretation of foot radiographs and management of cases presenting with foot Pain.

Keywords: Medial longitudinal arch, Medial foot pain, Os tibiale externum, Tibialis posterior tendon pathology

INTRODUCTION

The accessory navicular, also known as “Os tibiale externum”, “Os navicularum” or “prehallux”, is a developmental variant within the foot appearing secondarily due to failed fusion from a secondary ossification center off the navicular [1-5]. Os Navicular bone is the second most common ossicle of the foot which has an incidence of 4-28.3% in the general population [6-8]. There is a strong female predominance and may be bilateral in 50% to 90% of cases [9]. It is located on the postero-medial aspect of the foot adjacent to the postero-medial tuberosity of the navicular bone.

The accessory navicular has been associated with a normal foot posture and alignment, or sometimes with a flat (pes planus) foot. These usually remain asymptomatic, found incidentally on radiographs. They become symptomatic either due to trauma, degeneration, inflammation or infection of the feet. Accessory navicular bone has been commonly implicated as one of the cause for medial side foot pain, which when large can protrude medially and rub against footwear causing pain, which can be aggravated while walking, running and other weight bearing activities. It can also mimic a tarsal fracture. Hence, knowledge regarding the presence, incidence, location and morphology of Os Navicular is important for the radiologists and orthopaedic surgeons to arrive at a correct diagnosis which aids in the management of cases presenting with foot trauma. Hence, the present radiographic study on Os Navicular of the foot was taken up in our institute.

MATERIALS AND METHODS

Retrospective radiographic study of the incidence, anatomical variants & distribution of Os Navicular and accessory ossicles of the foot was conducted at Department of Radio-diagnosis ESIC Medical College & PGIMSR, K. K. Nagar, Chennai using radiographs of patients referred for X-rays of foot between January 2016-December 2017, after obtaining the permission from the Institutional Ethics Committee. Consecutive 1000 normal radiographs of the foot both anteroposterior & oblique views were used for the study which included both sexes and all age group between 12-80 years. Data collected by reading of both anteroposterior and oblique radiographs of the foot were recorded and analysed for the incidence, anatomical variants, location and distribution of Os Navicular bone in the foot. Radiographs of patients with incorrect patient positioning,

fractures of bones of foot and radiographs with any deformity or pathology of the bones of feet were excluded from the study.

STATISTICAL ANALYSIS

Statistical analysis was done by applying descriptive statistics. The categorical data is expressed in the manner of Percentage and presented by tables.

[Table/Fig-1]: Showing bipartite OSN in left foot.
[Table/Fig-2]: Showing tripartite OSN in right foot.

[Table/Fig-3]: Showing Type I OSN in right foot.
[Table/Fig-4]: Showing a large Type II OSN in right foot.

RESULTS

Out of 1000 radiographs of the foot, 144 cases of OSN were observed with varying shape and size which accounts for 14.4% incidence. OSN in the present study showed distinct margins with well corticated edges. Shape of the OSN observed in present study varied from small round, oval to triangular. Various anatomical variants such as bipartite[Table/Fig-1], tripartite [Table/Fig-2] OSN were also seen in the present study with an incidence of 2.08% and 0.69% respectively [Table/Fig-6]. In the present study we noticed that, the location of OSN to be consistent with posteromedial aspect of the navicular bone. All three types of OSN as per Geist classification were noted in the present study with Type II [Table/Fig-4] being the most predominant variant with incidence of 50%, while Type I [Table/Fig-3] with an incidence of 34.72% and Type III with an incidence of 15.27%. [Table/Fig-7].

[Table/Fig-5]: Showing Type III OSN in right foot.

Os Navicular	Types	Percentage
Single	140	97.22
Bipartite	3	2.08
Tripartite	1	0.69
Total	144	100

[Table/Fig-6]: Depicting the incidence of various anatomical variants of OSN.

Type of OSN	No. of Radiographs	Percentage
TYPE I	50	34.72
TYPE II	72	50
TYPE III	22	15.27
TOTAL	144	100

[Table/Fig-7]: Depicting incidence of various types of OSN.

DISCUSSION

Sesamoid bone is a small rounded bone embedded within a tendon or joint capsule. Sesamoid bones are typically found in locations where a tendon passes over a joint. They prevent the

friction between the tendon and the joint, protect the tendon and increase its biomechanical effect by changing the direction of pull of the tendon. On the other hand, accessory ossicles are usually derived from the failure of union of secondary ossification centres to the main bony mass [10,11].

The accessory navicular was first described by Bauhin in 1605 as an autosomal dominant congenital anomaly in which a tuberosity develops from a secondary center of ossification [12,13]. Three types of accessory navicular bone have been classified by Geist in 1914 based on morphology [13]. Type I is considered to be a sesamoid bone lying within the insertion of the tibialis posterior tendon. Type II results from a non fusion of secondary ossification center adjacent to the navicular bone; it is the insertion site of the posterior tibialis tendon and is connected to the navicular tuberosity by a synchondrosis. Type III accessory navicular bone is the result of fusion of the secondary ossification center with the navicular bone and is also called cornuate navicular [14].

Incidence of the Os Navicular varied from 4-28% [6,7,8], Coskun N et al., [1,10] reported an incidence of 11% and 11.7% in two studies among Turkish population. Tsuruta T et al., [11] reported OSN to be present in 733 out of 3,460 feet with an incidence of 21.3%, Huang J et al., [3] reported an incidence of 20.2% (329 out 1625 cases), Heba K et al., [15] reported 20.9 %(259/1240cases), While in the present study we observed an incidence of 14.4%.

The incidence of various types of OSN such as Type I, Type II and Type III Os Navicular were reported by Coskun N et al., [1] as 3.3, 3.1, 4.6%, Huang J et al., [3] as 41.6, 36.8 and 21.6, Heba K et al., [15] reported 25.4%, 42.4% 32.0% respectively, but in the present study the incidence of Type I, Type II and Type III Os Navicular as 34.72 %, 50 % and15.27% respectively. It was observed that the Type II was the most predominant among the Types of OSN which correlates with the study of Heba K et al., [15], but Coskun N et al., [1] and Huang J et al., [3] reported Type III as predominant variant.

Accessory navicular is usually present as anatomical and radiological variant. But sometimes it may be the source of foot pain. The differential diagnosis for symptomatic accessory navicular is tarsal stress fractures, arthritis and posterior tibial tendon rupture [16]. Out of these three patterns type II and cornuate navicular are associated with clinical manifestations particularly pain which is usually evident in second decade of life. When tibialis posterior tendon inserts either onto type II or III accessory navicular ossicle, the tendon is displaced resulting in valgus deformity which can later lead onto development of pes planus [17].

Painful accessory navicular may be due to trauma or degenerative changes at the synchondrosis or due to inflammation of soft tissue adjoining the bone [18]. Histopathology reveals inflammatory changes compatible with stress injuries. Continuous and vigorous movements of accessory navicular may traumatize leading to medial foot pain, which is more commonly seen in athletes.

Navicular in an intermediate tarsal bone located on the medial side of foot that articulates proximally with talus and distally with three cuneiform bones [19]. Tibialis posterior is an invertor of foot which inserts into the navicular bone assisting in plantar flexion of foot at the ankle joint and also assists in maintaining the medial longitudinal arch of the foot [20, 21]. This can be compromised when tibialis posterior inserts to accessory navicular if present, leading to loss of suspension of the tibialis posterior tendon, ultimately leading to the development of pes planus deformity [21-23]. However, there are no definitive cause and effect relationship between the accessory navicular and pes planus [24]. Sullivan JA [25] has even reported that accessory navicular plays no role in the development of a flat foot.

LIMITATIONS

Morphology of the anatomical variants can be studied in detail using advanced imaging modalities such as CT and MRI.

CONCLUSION

Radiologists and surgeons must be aware of normal variants of OSN in order, not to interpret these ossicles as avulsion fractures or a reverse situation in which an avulsion fracture should not be confused and evaluated as an accessory ossicle. In symptomatic cases by recognizing and treating this, progressive, debilitating deformity either conservatively or surgically, the surgeons will be able to resolve discomfort, improve dysfunction and restore quality of life of the patient.

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