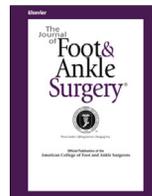




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Original Research

The Incidence and Anatomic Variation of Os Naviculare in a Multiethnic Asian Population

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ABSTRACT

The incidence of asymptomatic os naviculare ranges from 4% to 21%, varying between different ethnicities, with majority of studies performed in Caucasians. The aim of this study was to document the incidence of asymptomatic os naviculare in an Asian population stratified by ethnicity, and to characterize the features of each type. The records of all patients who underwent dorsoplantar and oblique foot radiographs between July and December 2017 were reviewed. We excluded patients with medial-sided foot pain. The radiographs of the remaining patients were reviewed and the incidence and type of os naviculare according to Coughlin's classification were recorded. About 439 patients were included. The overall incidence of asymptomatic os naviculare was 46.0%, of which 76.7% were bilateral. The prevalence of type Ia, Ib, and Ic os was 7.5%, 6.2%, and 5.9%, respectively. The prevalence of type IIa, IIAb, IIAc, IIBa, IIBb, and IIBc was 2.7%, 0.7%, 0.2%, 16.6%, 5.9%, and 2.1%, respectively. The prevalence of type IIIa, IIIb, and IIIc was 1.1%, 8.4%, and 0.2%. Type IIBa had the highest prevalence of 16.6% out of 439 patients. The highest incidence of os naviculare was in the Chinese population ($n = 145$, $p = .034$) at 50.2%. There was no significant gender difference in the incidence of asymptomatic os naviculare. The incidence of asymptomatic os naviculare in a multiethnic Asian population is higher than that reported in other populations, and particularly in the Chinese. Type IIBa was the most prevalent type, which differs from previous reports. When treating patients of Chinese ethnicity who present with pain over the medial aspect of the foot, the diagnosis of a symptomatic os naviculare should be considered.

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Accessory ossicles occur as a result of failure of union between the secondary ossification center to the main bone and are regarded as anatomic and radiographic variants rather than pathological findings. The majority are asymptomatic and usually incidentally detected on plain radiographs. However, these accessory ossicles can occasionally become fractured, dislocate or undergo degenerative changes, resulting in pain and reduced range of motion.

The os naviculare is one of the most common accessory ossicles in the foot, and has been reported to be present in 4% to 21% of the population (1–4). A symptomatic os naviculare can present with pain over the medial arch on weightbearing as a result of repeated microfracture of the synchondrosis or from inflammation of the posterior tibial tendon insertion.

Coughlin (2) classified the os naviculare into 3 main types. Type 1, also known as the os tibiale externum, consists of a sesamoid bone embedded within the distal portion of the posterior tibialis tendon and is usually asymptomatic. Type 2 consists of a triangular-shaped accessory bone attached to the navicular tuberosity by a thin layer of fibrocartilage and may cause posterior tibial tendon dysfunction. Sella and Lawson (5) further differentiated type 2 os naviculare into 2 subtypes: type A is connected to the navicular tuberosity by a less acute angle and type B is located more inferiorly. Type 3 refers to an accessory bone that has fused to the navicular tuberosity, creating a prominent bony tuberosity known as a cornuate navicular. Coughlin further subclassified these 3 main types into subtypes a, b, and c based on their radiographic appearance on the anteroposterior (AP) radiographic view (2).

The majority of the current literature on the incidence and anatomic variations of os naviculare has been largely conducted in non-Asian populations (6). Singapore is an island city state located in Southeast Asia and consists of an unique multiethnic Asian population with 4 main races: Chinese, Malay, Indians, and Eurasians. An understanding

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of the anatomical variations and incidence of os naviculare in our population can aid clinicians in the diagnosis and management of symptomatic patients. Hence, the aim of this study was to document the incidence of asymptomatic os naviculare in an Asian population stratified by ethnicity, and to characterize the features of each type.

Methods and Materials

The clinical records of all patients who underwent dorsoplantar and oblique foot radiographs between July 1, 2017 and December 31, 2017 at the department of radiology were reviewed. We excluded all patients who had undergone previous surgery to the foot, had a history of traumatic injury to the foot, skeletally immature individuals and those who presented with medial-sided foot pain.

The radiographs of the remaining patients were reviewed by a senior radiologist, and the presence, incidence and type of os naviculare according to Coughlin's classification (2) was recorded (Fig.).

We also recorded the ethnicity, age, gender, and site of the os naviculare.

We used the independent *t* test to compare continuous variables (age) between the 2 groups of patients and the Pearson chi-square test for categorical variables (gender, ethnicity, side of the os naviculare).

Statistical analysis was performed with SPSS statistical software, version 19.0 (IBM Corp., Armonk, NY) and statistical significance was set at $p < .05$.

Results

From a total of 519 patients, 439 patients were included in the study. The mean age of the patients included in the study was 50.3 ± 20.0 years. There were 223 (50.8%) men and 216 (49.2%) women. Within the study, 66.3% (291), 21.9% (96), 8.1% (38), and 1.1% (5) of the patients were of Chinese, Malay, Indian, and Eurasian ethnicity,

respectively, which was fairly proportionate to the distribution in our multiethnic population.

The overall incidence of asymptomatic os navicular was 46.0%, of which 76.7% were bilateral. Unilateral os naviculare was noted in 23.3% of the study group with 46.8% (22) located in the right foot and 53.2% (25) in the left foot. The mean age of patients with accessory navicular was 51.9 ± 19.5 years.

The prevalence of the different types of os naviculare according to Coughlin's classification is illustrated in Table 1. Type IIBa had the highest prevalence of 16.6% out of 439 patients.

Table 2 illustrates the prevalence of os naviculare according to age. The highest prevalence of asymptomatic os naviculare happened in the group aged from 51 to 60 years old. It was statistically higher ($p < .05$) compared to the group aged 21 to 30 years old (30.6%) but not the other age ranges. The group with the lowest prevalence of asymptomatic os naviculare was the 21 to 30 years old group. It was statistically lower compared to the age ranges of 51 to 60 (54.7%) and 71 to 80 (52.2%).

Table 3 illustrates the prevalence of os naviculare according to ethnicity. The highest incidence of os naviculare was in the Chinese ($n = 145$, $p = .034$) at 50.2%. There was no gender difference in incidence. Within each ethnic group, gender was not statistically associated with the presence of an os naviculare ($p > .05$; Table 4).

Discussion

The os naviculare was first described by Bauhin in 1605 (7). It has also been referred to as the accessory scaphoid or naviculare

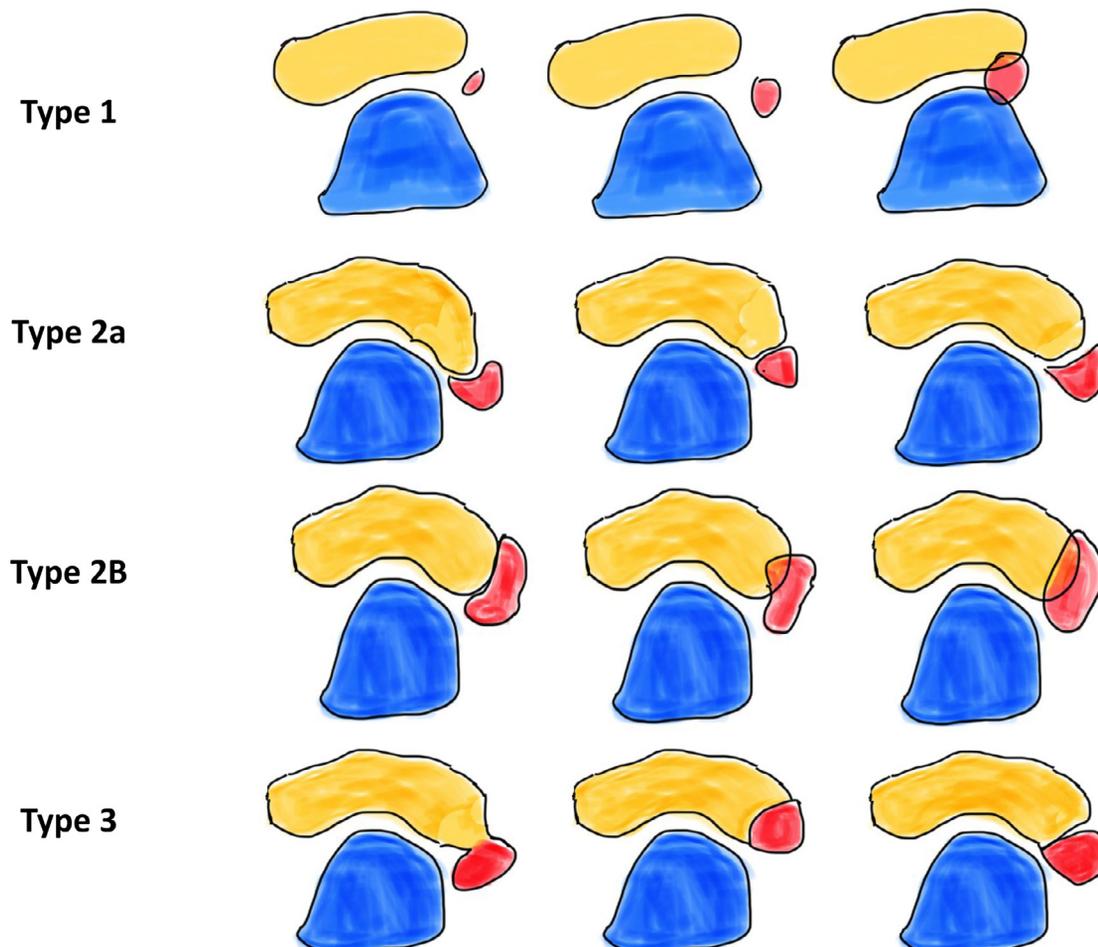


Fig. Schematic illustration of accessory navicular bone types using the modified Coughlin classification.

Table 1

The prevalence of the different anatomical types of os naviculare according to Coughlin's classification.

Type of Os		Prevalence (%) (n)
I	a	7.5% (33)
	b	6.2% (27)
	c	5.9% (26)
IIA	a	2.7% (12)
	b	0.7% (3)
	c	0.2% (1)
IIB	a	16.6% (73)
	b	5.9% (26)
	c	2.1% (9)
III	a	1.1% (5)
	b	8.4% (37)
	c	0.2% (1)

Table 2

The prevalence of os naviculare amongst the different age groups.

Age Range (Years)	n	Asymptomatic os Navicular Prevalence (%) (n)
<=20	39	48.7% (19/39)
21-30	62	30.6% (19/62)
31-40	44	47.7% (21/44)
41-50	57	42.1% (24/57)
51-60	86	54.7% (47/86)
61-70	81	44.4% (36/81)
71-80	46	52.2% (24/46)
81-90	22	50.0% (11/22)
>90	2	50.0% (1/2)

Table 3

The prevalence of os naviculare amongst the the distinct ethnic groups.

	Ethnicity		Prevalence		Total
			Absent os	Os Present	
Chinese	Number of patients:	145	146	291	
		% within ethnicity	49.8%	50.2%	100.0%
Malay	Number of patients:	55	41	96	
		% within ethnicity	57.3%	42.7%	100.0%
Indian	Number of patients:	26	12	38	
		% within ethnicity	68.4%	31.6%	100.0%
Eurasian	Number of patients:	4	1	5	
		% within ethnicity	80.0%	20.0%	100.0%
Others	Number of patients:	7	2	9	
		% within ethnicity	77.8%	22.2%	100.0%
Total	Number of patients:	237	202	439	
		% within ethnicity	54.0%	46.0%	100.0%

secundarium. While the majority of individuals with this supernumerary ossicle are asymptomatic, the os naviculare can become symptomatic. This occurs particularly during childhood and early adulthood as a result of tension, shear or compressive forces transmitted across the posterior tibial tendon to the fibrocartilaginous interface between the navicular tuberosity and ossicle following trauma, which can lead to microfractures and inflammation (8).

In our study, the prevalence of asymptomatic os naviculare was found to be 46.0%, higher than what is reported in other populations

Table 4

The prevalence of os naviculare stratified by gender within the various distinct ethnic groups.

Ethnicity	n	Female	Male	p Value
Chinese	291	54.3% (82/151)	45.7% (64/140)	.143
Malay	96	46.5% (20/43)	39.6% (21/53)	.497
Indian	38	33.3% (6/18)	30.0% (6/20)	.825
Eurasian	5	0.0% (0/1)	25.0% (1/4)	1.000
Others	9	0.0% (0/3)	33.3% (2/6)	.500

(1-4). In a similar study, Huang et al (9) found the incidence of symptomatic os naviculare in a predominantly Chinese population to be 20.2%, with the most common variant being type 1c. Our study found that the most common variant in our multiethnic population was Type IIBa, with a prevalence of 16.6%. The type II variant has most commonly implicated in cases of symptomatic os naviculare, possibly as a result of its larger size and the repetitive tension and shear stress across the synchondrosis due to the pull of the posterior tibial tendon (10).

Our study also found that the incidence of asymptomatic os naviculare was highest in the group aged 51 to 60 years. Huang et al also noted the incidence of symptomatic os naviculare to be highest in that age group and postulated the reason to be due to the development of progressive symptoms over a period of time (9).

To our knowledge, this is the first study describing the incidence and anatomic variation of asymptomatic os naviculare in a multiethnic Asian population. Our study population was also fairly representative of the ethnic population distribution in Singapore (11). An understanding of the profile of the population at risk of developing symptomatic os naviculare would facilitate making an earlier diagnosis and allow more efficient delivery of effective treatment.

Our study had several limitations. It was an observational study with a relatively small sample size. Asymptomatic patients were not followed up to determine if they develop symptoms. The morphology of the os naviculare variants were determined from plain radiographs, and the use of more advanced imaging such as computed tomography could have led to a different Coughlin subtype being assigned.

In conclusion, the incidence of asymptomatic os naviculare in a multiethnic Asian population is higher than that reported in other population, particularly in the Chinese. Type IIBa was the most prevalent type, which differs from that previous reports. Finally, when treating patients of Chinese ethnicity who present with pain over the medial aspect of the foot, the diagnosis of a symptomatic os naviculare should be considered.

Supplementary Materials

Supplementary material associated with this article can be found in the online version at <https://doi.org/10.1053/j.jfas.2021.05.013>.

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