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ORIGINAL ARTICLE

Relationship Between the of Type of Accessory Navicular Bone and Radiological Parameters of the Foot

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Background: In this study, we evaluated to the relationship between the type of accessory navicular bone (ANB) and radiological parameters of foot in patients with bilateral ANB of different types.

Methods: Patients with bilateral ANB of different types participated in this study, from May 2019 to April 2020. Patient data, including age, sex, body mass index (BMI), and presence of symptoms were obtained. We aimed to compare the radiological parameters of both the feet

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for evaluate the differences from one another in patients with bilateral ANB of different types (one side type 1 and contralateral side type 2) because the foot angles may differ in each person. Seven radiographic parameters were measured, including calcaneal pitch angle, talocalcaneal angle, tibiocalcaneal angle, naviculocuboid overlap, talonavicular coverage angle, anteroposterior talo-first metatarsal angle, and the lateral talo-first metatarsal angle, which evaluated hindfoot, midfoot, and forefoot alignment.

Results: Twenty patients (13 women and 7 men) with a mean age (and standard deviation) of 38.5 ± 12.3 years were included in the study. The patients had a mean height of 168.1 ± 7.1 cm, a mean weight of 77.2 ± 10.5 kg, and a mean BMI of 27.4 ± 4.3 kg/m^2. There was no significant difference between type 1 and type 2 in all radiological parameters. There was no significant correlation between radiological parameters and age, BMI, or the presence of symptoms.

Conclusions: We found that the type of ANB had no effect on the radiological measurements of the foot in which we evaluate the parameters patients with bilateral ANB of different types. Additionally, age, BMI, and the presence of symptoms, also demonstrated no correlation with the radiological parameters of the foot.

The accessory navicular bone (ANB) is one of the most common accessory bone of body which is foundin foot. It may found on the medial aspect of the foot, proximal to the navicular, and

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continuous with the tibialis posterior tendon (1). It may be incidentally found adjacent to the navicular bone, or may appear somewhat distincted from the navicular, to be possibly confused with an avulsion fracture (2). Shape, size, and anatomic site relative to the navicular bone can be used to classify accessory navicular bones, based on Geist classification Types 1–3 (1). Type 1 is a 2–3 mm sized sesamoid bone in the posterior tibial tendon, Type 2 exists from the secondary ossification center of the navicular bone, which is seen as triangular or heart-shaped, approximately 9 × 12 mm in size, with its base situated 1–2 mm from the medial and posterior aspects of the navicular bone. Type 3 navicular accessory bones are characterized by a bony ridged cornuate navicular connected to the medial aspect of the main navicular bone, often associated with remarkanle tuberosities in bursa or flat foot deformity (3, 5).

There is still no consensus on relationship between ANB and clinical or radiological parameters of foot (6, 7). In a study, Kanatlı et al investigated the medial longitudinal arch by evaluating the average arch index in patients with ANB and without ANB. In that study, they found no statistically significant difference between the group and ANB is not associated with flatfoot. (6). The relationship between symptomatic ANB and flatfoot has been investigated, and it has been found that the cause of pain has tended to overlook the degree of flatfoot deformity in patients with ANB (8, 9).

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In our study, we assessed the patients with bilateral and different types of (one side type 1 and the other type 2) ANB. We investigated to the relationship between the type of ANB and radiological parameters of foot in patients with bilateral ANB of different types.

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Material and Methods

This prospective descriptive cross-sectional research was performed utilizing the clinical symptoms and radiological parameters of foot from May 2019 to April 2020 at orthopedic department of single center. Patients with bilateral ANB of different types (one side type 1 and contralateral side type 2) were evaluated to participate who authorized the informed consent after the procedure was explained to them with details. The diagnosis of the presence and type of ANB were confirmed radiographically, which including bilateral weight-bearing lateral, oblique and anteroposterior (AP) views of each foot. All patients' feet radiographs were classified for type of ANB separately by each author and then were compared. The classifications showed perfect agreement with no discrepancy between the classifications of the both authors. This prospective cross-sectional was performed after approved by the ethic committee of our clinic.

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The inclusion criteria for this study were; all participants were over 18 years old, had a diagnosis of bilateral ANB of different types (one side possessed type 1 and contralateral with type 2) of ANB, established by radiological examination. We compared the parameters of both feet which included calcaneal pitch angle (CPA), talocalcaneal angle (TLCA), tibiocalcaneal angle (TCA), naviculocuboid overlap (NCO), lateral talo-first metatarsal angle (LTFA), talonavicular coverage angle (TNCA) and anterior talo-first metatarsal angle (ATFA) for each patient, in order to evaluate any differences and assess the effect of the type of ANB on the foot angles. These radiographic parameters predicate the alignment of each segment of the foot (10). The CPA, TLCA, and TCA were selected to describe hindfoot alignment. The NCO and TNCA were used to describe the alignment of the midfoot. The LTFA and ATFA were measured to describe forefoot alignment.

history of previous foot surgery, history of fractures in both lower extremities, patients over 65 years old (may have acquired pes planus or arthrosic joint of foot), body mass index (BMI) higher than 35 kg/m^2 (may have acquired pes planus), type 3 ANB (this type with enlarged navicular tuberosity which usually cause flat foot deformity or symptom in medial side of foot), and neuromuscular disease.

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Patient data including age, gender, side, body weight, body height, BMI, and presence of symptoms were obtained. Asymptomatic patients were incidentally diagnosed with bilateral ANB of different types, who consulted the our clinic for any foot-related complaint, such as tendinopathy of foot. Patients without symptoms were also included this study who reported no symptoms and sensitivity with palpation on the medial side of either foot during activity or rest was diagnosed asymptomatic patient.

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Radiological Evaluation

All radiographic measurements were performed using a picture archiving and communication system software (FONET PACS, Ankara). Initial radiological evaluation included weight-bearing AP, lateral, and oblique radiographies of both feet, using a same X-ray device at our center (Figure 1).All x-ray was carried out with patients in an upright position in a single designated X-ray unit. All measurements were taken one time by two authors (S.B and M.K) independently to decrease interobserver errors which found inter- class correlation coefficients= 0,993, 95% confidence interval [CI]= 0.990–0.996).

The radiological evaluation was performed by two senior authors (M.K. and S.B.), who independently evaluate the feet radiograph's which included seven radiographic indices

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measured for the evaluation of hindfoot, forefoot, and midfoot alignment of foot. Five of seven indices were measured on the lateral radiograph and the others were measure on AP radiograph.

These included: CPA which is the angle between a line drawn along the edge of the plantar aspect of the soft tissue shadow and a line drawn along the lower margin of the calcaneus. TLCA; the angle between the long axis of the talus and a line drawn along the lower margin of the calcaneus. TCA; the angle between the long axis of the tibia and a line drawn along the lower margin of the calcaneus. NCO; which evaluates hindfoot valgus and abduction (the greater the angle, the greater the degree of hindfoot abduction and valgus. Lastly, LTFA which is the angle between the long axis of the talar head and the long axis of the first metatarsal (Figure 2). The remaining two indices were measured on the AP view. These were the TNCA which is the angle between a line bisecting the anterior articular surface of the talus and a line bisecting the proximal articular surface of the navicular; and the ATFA, which is the angle between a line bisecting the anterior surface of the talus and the long axis of the first metatarsal (Figure 3).

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Statistical Analyses

All statistical analyses were performed using SPSS version 24.0 (IBM Corp, 2011, Armonk, New York). Descriptive statistical methods were used to evaluate the demographic data of study. Normality of distribution was assessed with the Shapiro-Wilk test. Student's t-test was used to compare quantitative, normally distributed variables of descriptive statistics (mean, standard deviation, minimum, and maximum), whereas the Mann–Whitney U test was used to compare non-normally distributed variables. A p value of less than 0.05 was accepted as statistically significant. Pearson correlation analysis was used to identify relationships between variables with normal distribution, and Spearman correlation was used for those variables that did not exhibit normal distribution.

Results

Twenty patients (13 women and 7 men) with a mean age (and standard deviation) of 38.5 ± 12.3 years (range, 18 to 57 years) were included in our study. The patients had a mean height of 168.1 ± 7.1 cm (range, 159 to 182 cm), a mean weight of 77.2 ± 10.5 kg (range, 55 to 94 kg), and a mean BMI of 27.4 ± 4.3 kg/m^2 (range, 21 to 34.3 kg/m^2) (Table I).

There was no significant difference between type 1 and type 2 ANBs for all radiological parameters (Table 2). Eight patients had symptoms on the medial side of their foot. Five of the

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eight symptomatic patients had symptoms on the type 2 side, two patients on the type 1 side, and the other on both feet. There was also no significant correlation between radiological parameters and age, BMI, or symptoms.

Discussion

The effect of ANB on the arc of the foot has been investigated in many studies, but is still uncertain (5–12). In present study, we intended to compare the radiological parameters of both the feet in all patients for evaluate the differences from one another in patients with bilateral ANB of different types (one side type 1 and contralateral side type 2) because the foot angles may differ in each person. We found that there were no significant difference between type 1 and type 2 ANBs for all radiological parameters. The type of ANB had no effect on the radiological parameters of foot.

Many studies exist regarding radiographic measurement methods, which have been used to evaluate the existence of pes planus with ANB feet (7, 11). Sullivian et al. reported on 208 patients with non-traumatic foot complaints, to determine the incidence of accessory navicular bones, and its association with flat foot; no relationship between flat foot and ANBs was found (7). Park et al. reported that the hindfoot was more in equinus posture (lower CPA), the midfoot was more pronated and abducted (higher NCO and TNCA), and the

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forefoot was more abducted and pronated (higher LTFA and ATFA) in patients with ANB, than in the normal control group (11).

The type 1 ANB accounts for 30% of ANBs, type 2 ANB is the most common (60% of ANBs), and type 3 ANB accounts for 10% of ANBs (2). A review of the literature shows that type 2ANB most often interferes with the function of the tibialis posterior tendon (13, 14)]. Kanatli et al. reported on 92 patients with ANB, investigating the medial longitudinal arch by using an "arch index" calculated from the pressure picture obtained from a pressure distribution measurement system (6). In that study, it was found that there was no relationship between arch height and ANB types. In our study, where each patient's own measurements were compared with their contralateral side, we found that the types of accessory navicular bone had no effect on the radiological measurements of the foot.

The presence of ANB may be a cause of pain and sensitivity with palpation especially at the medial side of foot, considered symptomatic ANB (14, 15). Some authors emphasized that abnormal insertion of the tibialis posterior into the ANB alters the leverage of this tendon, interfering with normal tarsal mechanics and producing weakness of the longitudinal arch, and a resulting painful flat foot (16, 17) However, other studies found that pain was thought to be the result of local mechanical factors associated with the ANB itself (6, 11, 16). In their large series, Park et al. found that no significant radiologic differences were seen between patients with

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symptomatic and asymptomatic ANBs (11). In our study, we also found no significant correlation between radiological parameters and the presence of symptoms in either type 1 or type 2 ANBs.

Pita-Fernández et al. performed a cross-sectional study which included 1,002 patients aged 40 years and above (18). In that study they found that the age, BMI and gender were related with a flatfoot. Another study by Yousefi Azarfam et al. examined the association between BMI and static footprint parameters in the elderly population (19). In that study, they reported that BMI and footprint parameters are determinative of flatfoot in the elderly patients. In present study, there was no significant correlation between radiological parameters and BMI.

Some limitations of the present study are worth considering. First, there were a small number of patients in this study. However, patients with bilateral ANB of different types are extremely rare. There was no control group of patients, without ANB, to compare with our groups. In our study, patients were not evaluated for flat foot deformity.
Lastly, the confounding factors, such as genetics, may affect the radiological measurement.

Conclusions

We found that the type of ANB had no effect on the radiological measurements of the foot in which we evaluate the parameters patients with bilateral ANB of different types. Additionally,

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age, BMI, and the presence of symptoms, also demonstrated no correlation with the radiological parameters of the foot.

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Conflict of Interest: None reported.

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Table-1: Demographic data of the patients

	Mean ± SD	Min-Max
Age, years	38.5 ± 12.3	18-57
Gender, F/M	13/7	
Weight, kg	77.2 ± 10.5	55-94
Height, cm	168.1 ± 7.1	159-182
Body Mass Index, kg/m^2	27.4 ± 4.3	21-34.3

SD: Standard Deviation: Min: Minimum; Max: Maximum; kg: kilogram; cm; centimeter;

Table-2: Comparison of radiological parameters in type 1 and 2 ANB.

	Type 1 ANB		Type 2 ANB		
	Mean ± SD	Min-Max	Mean ± SD	Min-Max	p value
CPA	15.2 ± 4.7	5-23	16.3 ± 4.3	7-24	0.466
TLCA	41.8 ± 6.8	31-55	43.2 ± 7.2	30-54	0.527
TCA	70 ± 14.6	53-117	63.5 ± 4.6	57-70	0.061
NCO (%)	54 ± 10	31-73	56 ± 12	39-80	0.533
LTFA	8.4 ± 4.8	3-20	8.9 ± 3.7	2-18	0.727
TNCA	12.2 ± 3.7	6-19	12 ± 3.4	5-18	0.851
ATFA	12.6 ± 4	4-20	13.8 ± 5.7	2-26	0.465

SD: Standard Deviation; Min: Minimum; Max: Maximum; CPA: Calcaneal pith angle; TLCA: Talocalcaneal angle; TCA: Tibiocalcaneal angle; NCO: Naviculocuboid overlap % LTFA: Lateral talo–first metatarsal angle; TNCA: Talonavicular coverage angle ATFA: anteroposterior talo–first metatarsal angle.

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Figure-1: The patient had bilateral accessory navicular bone which was type 2 on the right side and type 1 on the left side.

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Figure 2A: Calcaneal pitch angle is the angle between a line drawn along the edge of the plantar aspect of the soft tissue shadow and a line drawn along the lower margin of the calcaneus.

Figure 2B: TLCA is the angle between the long axis of the talus and a line drawn along the lower margin of the calcaneus.

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Figure 2C: TCA is the angle between the long axis of the tibia and a line drawn along the lower margin of the calcaneus.

Figure 2D: NCO: 1-2, superior and inferior margins of the cuboid; 3; inferior margin of the navicular, 1-3/1-2 (%100).

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E: LTFA is the angle between the long axis of the talar head and the long axis of the first metatarsal bone.

Figure 3A: TNCA is the angle between a line bisecting the anterior articular surface of the talus and a line bisecting the proximal articular surface of the navicular.

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Figure 3B: ATFA is the angle between a line bisecting the anterior surface of the talus and the long axis of the first metatarsal bone.