ISSN 2307-8960 (online)

World Journal of *Clinical Cases*

World J Clin Cases 2023 December 16; 11(35): 8242-8433

Published by Baishideng Publishing Group Inc

World Journal of Clinical Cases

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RESPONSIBLE EDITORS FOR THIS ISSUE

NAME OF JOURNAL
World Journal of Clinical Cases

ISSN
ISSN 2307-8960 (online)

LAUNCH DATE
April 16, 2013

FREQUENCY
Thrice Monthly

PUBLICATION DATE
December 16, 2023

World Journal of Clinical Cases

Submit a Manuscript: https://www.f6publishing.com

World J Clin Cases 2023 December 16; 11(35): 8256-8262

DOI: 10.12998/wjcc.v11.i35.8256

ISSN 2307-8960 (online)

MINIREVIEWS

Accessory navicular in children

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Specialty type: Orthopedics

Provenance and peer review: Invited article; Externally peer reviewed.

Peer-review model: Single blind

Peer-review report's scientific quality classification

Grade A (Excellent): 0
Grade B (Very good): 0
Grade C (Good): C
Grade D (Fair): 0
Grade E (Poor): 0

P-Reviewer: Lee SH, South Korea

Received: August 23, 2023
Peer-review started: August 23, 2023
First decision: November 1, 2023
Revised: November 6, 2023
Accepted: December 4, 2023
Article in press: December 4, 2023
Published online: December 16, 2023

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Abstract

Accessory navicular (AN) is a developmental variation of the secondary ossification center of the navicular tuberosity. Ten percent of patients with AN will have pain symptoms that affect walking and life. As the AN changes the position of the posterior tibial tendon insertion, children with AN often have posterior tibial tendon function insufficiency and flexible flat foot. Surgical treatment is often required after failure of conservative treatment. This article reviewed the etiology, clinical manifestations, complications, and treatment methods of AN.

Key Words: Accessory navicular; Posterior tibial tendon; Flexible flatfoot; Kidner procedure; Treatment

Core Tip: Accessory navicular is a developmental variation of the secondary ossification center of the navicular tuberosity. Ten percent of patients with accessory navicular will have pain symptoms that affect walking and life. Because the accessory navicular changes the position of the posterior tibial tendon insertion, children with accessory navicular often have posterior tibial tendon function insufficiency and flexible flatfoot. Surgical treatment is often required after failure of conservative treatment. This article reviewed the etiology, clinical manifestations, complications, and treatment methods of accessory navicular.

Citation: Xiang F, Liu ZQ, Zhang XP, Li YJ, Wen J. Accessory navicular in children. *World J Clin Cases* 2023; 11(35): 8256-8262
URL: https://www.wjgnet.com/2307-8960/full/v11/i35/8256.htm
DOI: https://dx.doi.org/10.12998/wjcc.v11.i35.8256

INTRODUCTION

Accessory navicular (AN) is a developmental variation of the secondary ossification center of the navicular tubercle. Ossification of AN begins at approximately 9 years of age in females and 12 years of age in males. It is usually caused by failure of the secondary ossification center to heal with the navicular bone. AN is an autosomal dominant congenital malformation with an estimated prevalence of 10%-12% in children[1]. Studies have shown that females develop the disease earlier than males[1-3]. Surgical intervention is often needed if conservative treatment for painful AN fails, but there are numerous complicated surgical treatment methods and no unified surgical standard. In this study, the causes, types, imaging evaluation, relationship with flat foot, surgical treatment options, and the advantages and disadvantages of these treatment options were reviewed.

The causes of AN pain are still controversial[4] and include the following: posterior tibial tendinitis; articular cartilage injury; ligament relaxation; bursa inflammation of bony elevation; flat foot; and biomechanical changes in the middle of the foot. There is currently no unified view to support them. AN pain is most common in the medial side of the foot during puberty. Occasionally, pain symptoms begin in the ankle. In some patients with symptomatic paravicularis, foot valgus deformity may occur. Kim *et al*[5] postulated that biomechanical changes of the posterior tibial tendon were the main cause of painful AN, and diabetes was a risk factor for posterior tendinopathy.

The severity of pain is associated with edema of the soft tissue covering the AN, which may result from friction of the soft tissue caused by external compression resulting in bursitis or in response to biomechanical stress or direct trauma[6]. During magnetic resonance imaging of the ankle joint, Gursoy *et al*[7] observed that tendinopathy was greater in AN patients than in normal individuals. In patients with AN, edema of the posterior tibial tendon was significantly greater. Bone marrow edema was also observed in athletes with AN[2].

The prevalence of AN bone is relatively high; however, less than 1% of patients with AN bone have pain symptoms in the clinic[8]. In the study by Kalbouneh *et al*[9], 10% of AN patients had pain symptoms. Although AN is rarely associated with pain syndromes, clinicians must be familiar with these variants to avoid misinterpreting them as avulsion fractures[10].

CLASSIFICATION

AN bone can be divided into three types according to its relationship with the navicular bone[2]: Type I AN is completely separate from the scaphoid bone and is round or oval; Type II AN is contiguous but not fused with the navicular bone, connected to the navicular body of the foot by fibrocartilage, is triangular or cordate, and can be subdivided into type IIa (AN is in front of the navicular bone, above the navicular bone) and type IIb (AN is behind the navicular bone, below the position of type IIa); and Type III AN is fused to the scaphoid bone and forms a bony fusion, beak, or horn bone type. Regarding type II AN, Kamel *et al*[11] divided it further into three levels according to the severity of collateral navicular bone marrow edema: Grade 1, the weak signal is similar to synchondrosis; Grade 2, the medium signal is located in the AN and navicular tubercles but does not extend to the navicular bone; and Grade 3, the strong signal extends into the navicular bone.

RADIOLOGY

X-ray with weight bearing position is an important basis for selecting surgical methods for patients with AN. When necessary, 45° oblique film is taken to identify the subtypes of type II AN[12]. The degree of foot abduction is assessed by measuring the first plantar calcaneum angle and talonavicular covering angle in the anterolateral position. When the talonavicular covering angle is greater than 10°, this indicates a lateral dislocation of the scaphoid against the talus. Lateral radiology measurement of the Meary angle greater than 4° indicates the presence of flat foot. The normal value of the heel distance angle (kite angle) is between 25° and 45°, and when the angle exceeds 45°, this indicates that the foot is ectropion. The normal Pitch angle of the calcaneus is between 17° and 32°, and less than 17° indicates arch collapse.

These angles are of great significance in the classification of AN and the diagnosis of whether it is combined with flat foot[2]. In the differential diagnosis of avulsion fractures of the navicular and AN, a 99mTcMDP bone scan[13] and computed tomography examination are sometimes required; however, computed tomography examination has no obvious significance for diagnosis and classification. Early identification of the cause of pain is also feasible with magnetic resonance imaging, which can not only determine the degree of myelopathy but also the scope of posterior tendinopathy, with high sensitivity and specificity. However, it is expensive and not the first choice. B-ultrasound plays an essential role in evaluating the integrity of the transposterior tendon and degeneration of articular cartilage. It can also perform dynamic localization of tender points and can be used to accurately block pain points to improve pain symptoms.

ASSOCIATION WITH FLAT FOOT

AN is usually associated with flat feet[12,14], but there is not necessarily a causal relationship between the two. Therefore, they should be evaluated and treated separately. The treatment method is controversial, and the clinical effect of various surgical methods is different. Depending on whether the AN bone is combined with flat foot, whether there are symptoms, and how to reconstruct the arch after AN resection, the clinical effect of various surgical methods is also different. Both holistic consideration and independent evaluation are needed to achieve the optimal treatment of AN with flat foot[15]. Some studies have suggested that the deformity of flat foot is a secondary change of AN, which is related to dysfunction of the posterior tibial tendon[16]. It has also been reported that formation of the scaphoid bone is not caused by AN but by excessive tension and pulling of the posterior tibial tendon. The degree of flat foot has nothing to do with the development and severity of symptoms in patients with AN[4]. AN may present with painful symptoms in childhood, which is associated with gradual flattening of the arch. During childhood development and adolescence, the arch will gradually develop with age, and the pain symptoms will disappear.

Other studies have suggested that the Kidner procedure may not be necessary during the surgical treatment of soft flat feet in children with painful type II AN bone. Pain in the AN bone region is likely to be relieved with preservation of the AN bone, while reconstruction of the posterior tibial tendon is only slightly helpful for reconstruction of the medial arch [17]. Tian *et al*[18] used a 5 mm spring ligament resection to tighten it and internal fixation of medial cuneus osteotomy to stabilize the medial column in order to effectively maintain the medial longitudinal arch and correct the flat foot deformity in AN. Kim *et al*[19] studied the rigid flat foot of children and adolescents with symptomatic AN using calcaneo-cuboid-cuneiform osteotomy and a modified Kidner procedure. They concluded that both surgical methods significantly improved pain symptoms and the angle of the talonavicular covering and calcaneal inclination angle in the anterolateral bearing position.

Other studies suggested that the more severe the degree of flat foot, and the earlier the onset, the greater the benefit patients gained from surgical resection[6]. Studies have suggested that flat feet or posterior tendon dysfunction is particularly related to AN type II and III[20]; thus, there may be a correlation between flat feet and symptomatic AN. However, Cha *et al*[21] did not detect a clear correlation between AN and flat foot, and the relationship between AN and flat foot was a separate issue. Shi *et al*[22] reported that subtalar joint fusion combined with medial soft tissue reconstruction is suitable for children and adolescents with scaphoid bone combined with flexible flat foot. This procedure can significantly reduce the pain and improve the function of patients. Its advantage is that it can restore the arch of the foot without loosening internal implants, relieve pain, and improve the function of the affected foot, but the disadvantage is that it causes pain and swelling in the sinus tarsi region. Excessive screw placement may result in a second operation to remove and replace the screw, resulting in scaphoid nonunion. Similarly, the subtalar arthroereisis combined with modified Kidner procedure reported by Fang *et al*[23] is suitable for adolescents with painful accessory scaphoid bone combined with flexible flat foot. Its advantages are to restore the foot arch, relieve pain, and improve the function of the affected foot, while its disadvantages are tarsal sinus pain and local pain recurrence of accessory scaphoid bone.

TREATMENT

The treatment of painful AN includes conservative treatment, simple AN excision, the Kidner procedure, the modified Kidner procedure, different internal fixation of AN excision, minimally invasive fusion, and fixation and fusion of AN and the navicular.

Conservative treatment

Conservative treatment is the first choice for early painful AN, but for athletes, surgical treatment is more conducive to rehabilitation than conservative treatment[8]. Conservative treatment includes: (1) Wear loose shoes to prevent friction between the medial side of the midfoot and the shoe and avoid strenuous exercise; (2) Isometric contraction exercise of toes grasping the ground to enhance the strength of the posterior tibial tendon to increase the height of the foot arch; (3) Immobilizing the affected foot to improve local pain symptoms; and (4) Local physical therapy and oral nonsteroidal pain medication to control symptoms. At present, it is recognized that if the pain symptoms are not relieved or worsen after 6 mo of conservative treatment, surgical treatment is required.

Simple AN resection

A skin incision is made on the surface of the AN, the AN is exposed, the posterior tibial tendon is dissected, and AN and painful bursa are sutured after resection along the dorsal side of the insertion of the posterior tibial tendon. This procedure is characterized by no disruption of the plantar side of the posterior tibial tendon, but if any part of the posterior tibial tendon is dissected, it is refixed and attached to its original position. Simple AN resection has the advantage of minimal trauma and can effectively reduce the incidence of pain complications[24]. The disadvantage is that it does not improve the arch height. The relative lengthening of the posterior tendon may increase the risk of arch collapse and aggravate the flat foot deformity. When AN is larger than 7 mm, it will form a defect between the posterior tibial tendon and the navicular. Therefore, simple resection is not suitable for AN larger than 7 mm[25]. Patients with posterior tibial tendon function insufficiency are also not suitable for simple AN resection, as it will aggravate the risk of flat foot. However, AN resection combined with posterior tibial tendon tightening can effectively alleviate the occurrence of postoperative pain and complications, and is suitable for athletes[26]. Pretell *et al*[27] reported that in a comparison between AN resection alone and AN resection combined with posterior tibial tendon reconstruction, there was no

significant difference in the clinical results between the two surgical methods. However, the number of complications after AN plus tibial tendon reconstruction was greater than that after simple AN resection alone, and there was the possibility of secondary surgery.

The Kidner procedure

The aims of this operation are to remove the AN and navicular tuberosity, completely cut the posterior tibial tendon attached to AN, partially cut the posterior tibial tendon bundle, and then reconstruct the severed posterior tibial tendon on the metatarsal side of the navicular tuberosity to restore the direction of the force line of the posterior tibial tendon. After the bone tunnel is established, the posterior tendon is fixed by internal fixation, and the tendon sheath is repaired layer by layer. After the operation, a varus cast is fixed for 2 wk, and then fixation is changed to the neutral position for 2 wk. The advantage of this procedure is that it can restore the height of the foot arch, restore the alignment of the posterior tibial tendon, and relieve pain. The disadvantages of this procedure include bone nonunion, destructive bone, scaphoid fracture, degeneration of the posterior tibial tendon, and recurrent pain. Theoretically, AN resection may lead to an increased risk of nonunion of the bone-tendon interface after posterior tibial tendon reconstruction, and excessive contraction of the reconstructed posterior tibial tendon has a significant impact on stability, which is also the reason for the lack of significant relief regarding postoperative pain symptoms[28]. Although the relationship between the AN-navicular joint and foot valgus is controversial[29], Choi *et al*[30] suggested that recurrent pain symptoms after the Kidner procedure were related to flat foot or hindfoot valgus. However, Kim *et al*[31] suggested that if recurrent pain occurs after surgery, the pain symptoms can be relieved by aligning the heel after calcaneal medial displacement osteotomy.

Modified Kidner procedure

The posterior tibial tendon is exposed by removing the AN cartilage junction and local fusion of the scaphoid and by removing the tissue approximately 4 cm above the superior border of the posterior tibial tendon. The cartilage joint between AN and the navicular is located, the cartilage is removed, the AN and the navicular tuberosity are separated, AN is removed from the fusion surface, the fusion surface is drilled with Kirschner wire, the accessory scaphoid is moved to the distal metatarsal side and fixed with an anchor, and the posterior tendon is sutured layer by layer. The procedure does not require casting, but the foot needs to be weight-free for 6 wk. The advantages of this procedure are reconstruction of the posterior tibial tendon and preservation of its integrity, pain relief, and improvement in the height of the foot arch. The disadvantages are bone nonunion, navicular fracture, bone destruction, and major trauma. Kim *et al*[32] used the modified Kidner procedure to treat 11 cases (14 feet) with painful AN in adolescents, and postoperative follow-up showed excellent results in 7 cases and good results in 4 cases. Luo *et al*[33] used the modified Kidner procedure combined with tenoscopy to treat painful AN, which significantly relieved foot pain and improved foot function.

Selection of internal fixation

Various studies have reported different internal fixation methods, including anchor, hollow screw, Kirschner wire, *etc*, which can be used for scaphoid fixation[34]. Jang *et al*[35] compared screw and tension band internal fixation for painful accessory scaphoid fixation and concluded that there was no significant difference between the two methods. The size of AN is too small for bone fusion. The internal fixation method should be selected according to the diameter of AN. Internal fixation complications include internal fixation breakage and loosening, fracture, and postoperative pain. The posterior tibial tendon can also be sutured directly at the bone-tendon contact. Kakihana *et al*[36] suggested that a suture anchor may be the first choice for the treatment of AN with persistent pain in adolescents.

Percutaneous drilling technique

Kirschner wire is inserted percutaneously from the posterior part of the AN process to the navicular through the symphysis cartilage, and the wires penetrate at different points (average, 6 points) under X-ray guidance. The foot is fixed in an infra-knee cast in the moderate equinovarus position for 3 wk. Full weight-bearing is performed 1 wk after cast removal, and the cartilage union is drilled percutaneously to facilitate fusion. The advantages of this operation are less trauma, no incision, no change in the biological force line of the posterior tendon, and few complications. The disadvantages are a high incidence of bone nonunion and recurrence of pain caused by failure of fusion. Nakayama *et al* [37] reported that 29 patients (31 feet) with painful accessory scaphoid bone were treated by percutaneous drilling, and the postoperative follow-up results showed excellent and high satisfaction in up to 96% of feet.

Percutaneous arthroscopic surgery

The surface landmarks of the posterior tendon, navicular, and AN are drawn preoperatively. The navicular and AN cartilage symphysis are found by fluoroscopy, and a needle is inserted into the cartilage symphysis and used as a marker. The metatarsal side of the navicular is the entrance for observation, and the dorsal side is the entrance for surgery. The plantar portion of the symphysis is incised, taking care not to extend beyond the lateral plantar border of the articular cartilage symphysis. After removing the interarticular cartilage, reduction of the joint symphysis is completed by close attachment of the navicular-AN joint. Cannulated screws are inserted through the cartilage symphysis under fluoroscopy. A short leg cast is used to maintain the ankle in the dorsiflexion and adduction position. The cast is maintained for 4-6 wk without weight bearing. The advantages of this procedure are better cosmetic results, less scar pain, reduced risk of nonunion, and the potential to preserve the posterior tibial tendon and talonavicular joint[38]. The disadvantage of this technique is that it is difficult to popularize and carry out.

Table 1 The therapeutic effect of different treatment methods on accessory navicular reported in the literature

Ref.	Surgical method	Cases	Results as good/complications
Jasiewicz *et al*[25], 2008	Simple AN resection	22	20/2
Cha *et al*[21], 2013	Simple AN resection	25	24/1
Cha *et al*[21], 2013	Kidner procedure	25	24/1
Zeng *et al*[42], 2020	Kidner procedure	10	9/1
Kim *et al*[31], 2020	Modified Kidner procedure	11	11/0
Luo *et al*[33], 2021	Modified Kidner procedure	19	19/0
Nakayama *et al*[37], 2005	Percutaneous drilling	29	29/0
Chung *et al*[40], 2009	Navicular-AN joint fusion	31	25/6
Zeng *et al*[42], 2020	Navicular-AN joint fusion	6	5/1
Shi *et al*[22], 2023	Subtalar arthroereisis combined with medial soft tissue reconstruction	35	32/3
Fang *et al*[23], 2023	Modified Kidner procedure combined with subtalar arthroereisis	25	22/3

AN: Accessory navicular.

Navicular-AN joint fusion

The upper edge of the posterior tibial tendon is exposed and removed, and the cartilage joint between the AN and the navicular is located. The articular cartilage is scraped off with a scraping spoon, AN is separated from the navicular tuberosity, and the protruding bony processes of the fusion surface are removed in order for the fusion surface to be flat. The fusion surface is drilled evenly with Kirschner wire, and AN is moved to the distal metatarsal side and fixed. Casting is not required, but the foot should be free of weight bearing for 6 wk. The advantages of this procedure are that it is suitable for accessory scaphoid bone larger than 7 mm[25], reconstruction of posterior tibial tendon, and preservation of its integrity without changing the biological force line of the posterior tibial tendon, and improvement in pain. The disadvantages are nonunion, recurrent pain, foot valgus, and collapse of the arch. Only the joint between the accessory scaphoid and the interscaphoid of the foot is cleared, and insertion of the posterior tibial tendon is not reconstructed[27]. Knupp *et al*[39] reported the 1-year follow-up results of navicular-AN joint fusion and showed significant pain relief and bone healing without complications of medial arch collapse. However, Chung *et al*[40] reported a high incidence of nonunion following the navicular-AN joint fusion procedure. Fritz *et al*[41] suggested that fusion or fusion failure may be attributed to improper choice of footwear and/or type of physical activity. Zeng *et al*[42] reported that in adolescents, navicular-AN joint fusion and the Kidner procedure had similar therapeutic effects in type II painful AN. For type II painful AN with mild to moderate flat foot, the mid-term pain and function after fusion are satisfactory, but the rate of bone nonunion is high[43].

CONCLUSION

Before choosing the treatment method for painful AN, the cause of pain should be determined, and attention should be paid to distinguish it from other causes of medial midfoot pain. At present, conservative treatment is still the first choice, and surgical treatment should be considered when the pain is not relieved by conservative treatment. Classification is significant for guiding the choice of surgical methods, but there is no unified surgical method. Each surgical method has its advantages and disadvantages (Table 1), and individualized treatment should be adopted according to the specific conditions of each child.

FOOTNOTES

Co-corresponding authors: Yan-Jun Li and Jie Wen.

Author contributions: Xiang F is the first author; Li YJ and Wen J contributed equally to this study, and they share co-corresponding authorship; Li YJ conceived, designed, and coordinated the study; Xiang F performed the literature search and wrote the paper; JW contributed to data analysis; Liu ZQ and Zhang XP carried out the data collection and revised the paper; All authors reviewed the results and approved the final version of the manuscript.

Conflict-of-interest statement: All the authors declare that they have no competing interests.

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S-Editor: Liu JH
L-Editor: Filipodia
P-Editor: Liu JH

REFERENCES

1 **Knapik DM**, Guraya SS, Conry KT, Cooperman DR, Liu RW. Longitudinal radiographic behavior of accessory navicular in pediatric patients. *J Child Orthop* 2016; **10**: 685-689 [PMID: 27807730 DOI: 10.1007/s11832-016-0777-x]
2 **Jegal H**, Park YU, Kim JS, Choo HS, Seo YU, Lee KT. Accessory Navicular Syndrome in Athlete vs General Population. *Foot Ankle Int* 2016; **37**: 862-867 [PMID: 27090634 DOI: 10.1177/1071100716644791]
3 **Perdikakis E**, Grigoraki E, Karantanas A. Os naviculare: the multi-ossicle configuration of a normal variant. *Skeletal Radiol* 2011; **40**: 85-88 [PMID: 20454960 DOI: 10.1007/s00256-010-0944-y]
4 **Park H**, Hwang JH, Seo JO, Kim HW. The Relationship Between Accessory Navicular and Flat Foot: A Radiologic Study. *J Pediatr Orthop* 2015; **35**: 739-745 [PMID: 25393575 DOI: 10.1097/BPO.0000000000000359]
5 **Kim KT**, Chung ME. Musculoskeletal problems in lower extremity after stroke. *Brain Neurorehabil* 2016; **9**: 13-19 [DOI: 10.12786/bn.2016.9.1.13]
6 **Kamel SI**, Belair JA, Hegazi TM, Halpern EJ, Desai V, Morrison WB, Zoga AC. Painful type II os naviculare: introduction of a standardized, reproducible classification system. *Skeletal Radiol* 2020; **49**: 1977-1985 [PMID: 32556471 DOI: 10.1007/s00256-020-03503-y]
7 **Gursoy M**, Dirim Mete B, Cetinoglu K, Bulut T, Gulmez H. The coexistence of os trigonum, accessory navicular bone and os peroneum and associated tendon and bone pathologies. *Foot (Edinb)* 2022; **50**: 101886 [PMID: 35219130 DOI: 10.1016/j.foot.2021.101886]
8 **Lui TH**. Endoscopic Accessory Navicular Synchondrosis Fusion. *Arthrosc Tech* 2016; **5**: e1267-e1272 [PMID: 28149724 DOI: 10.1016/j.eats.2016.07.018]
9 **Kalbouneh H**, Alajoulin O, Alsalem M, Humoud N, Shawaqfeh J, Alkhoujah M, Abu-Hassan H, Mahafza W, Badran D. Incidence and anatomical variations of accessory navicular bone in patients with foot pain: A retrospective radiographic analysis. *Clin Anat* 2017; **30**: 436-444 [PMID: 28295608 DOI: 10.1002/ca.22876]
10 **Nwawka OK**, Hayashi D, Diaz LE, Goud AR, Arndt WF 3rd, Roemer FW, Malguria N, Guermazi A. Sesamoids and accessory ossicles of the foot: anatomical variability and related pathology. *Insights Imaging* 2013; **4**: 581-593 [PMID: 24006205 DOI: 10.1007/s13244-013-0277-1]
11 **Knapik DM**, Archibald HD, Xie KK, Liu RW. A retrospective study on factors predictive of operative intervention in symptomatic accessory navicular. *J Child Orthop* 2019; **13**: 107-113 [PMID: 30838083 DOI: 10.1302/1863-2548.13.180168]
12 **Vaughan P**, Singh D. Ongoing pain and deformity after an excision of the accessory navicular. *Foot Ankle Clin* 2014; **19**: 541-553 [PMID: 25129360 DOI: 10.1016/j.fcl.2014.06.010]
13 **Chong A**, Ha JM, Lee JY. Clinical Meaning of Hot Uptake on Bone Scan in Symptomatic Accessory Navicular Bones. *Nucl Med Mol Imaging* 2016; **50**: 322-328 [PMID: 27994687 DOI: 10.1007/s13139-016-0452-7]
14 **Coughlin MJ**, Saltzman CL, Anderson RB. (eds.). Sesamoids and Accessory Bones of the Foot. In: Mann's Surgery of the Foot and Ankle. 9th ed. Saunders/Elsevier; 2013: 544-553
15 **Garras DN**, Hansen PL, Miller AG, Raikin SM. Outcome of modified Kidner procedure with subtalar arthroereisis for painful accessory navicular associated with planovalgus deformity. *Foot Ankle Int* 2012; **33**: 934-939 [PMID: 23131438 DOI: 10.3113/FAI.2012.0934]
16 **Alsager GA**, Alzahrani K, Alshayhan F, Alotaibi RA, Murrad K, Arafah O. Prevalence and classification of accessory navicular bone: a medical record review. *Ann Saudi Med* 2022; **42**: 327-333 [PMID: 36252147 DOI: 10.5144/0256-4947.2022.327]
17 **Gan TJ**, Liu X, Li YX, Chen Y, Li J, Zhang H. Is Kidner procedure necessary during subtalar arthroereisis for pediatric flexible flatfoot that combined with symptomatic type 2 accessory navicular? A retrospective comparative study. *Foot Ankle Surg* 2023; **29**: 393-400 [PMID: 37221108 DOI: 10.1016/j.fas.2023.05.003]
18 **Tian F**, Wang J, Liu C, Li Y, Liang X, Wang X. Medial column reinforcement for the correction of flatfoot deformity with accessory navicular bone. *Am J Transl Res* 2022; **14**: 6368-6374 [PMID: 36247284]
19 **Kim JR**, Park CI, Moon YJ, Wang SI, Kwon KS. Concomitant calcaneo-cuboid-cuneiform osteotomies and the modified Kidner procedure for severe flatfoot associated with symptomatic accessory navicular in children and adolescents. *J Orthop Surg Res* 2014; **9**: 131 [PMID: 25480361 DOI: 10.1186/s13018-014-0131-2]
20 **Campbell JT**, Jeng CL. Painful Accessory Navicular and Spring Ligament Injuries in Athletes. *Clin Sports Med* 2020; **39**: 859-876 [PMID: 32892972 DOI: 10.1016/j.csm.2020.05.002]
21 **Cha SM**, Shin HD, Kim KC, Lee JK. Simple excision vs the Kidner procedure for type 2 accessory navicular associated with flatfoot in pediatric population. *Foot Ankle Int* 2013; **34**: 167-172 [PMID: 23413054 DOI: 10.1177/1071100712467616]
22 **Shi C**, Li M, Zeng Q, Wen X, Tian F, Li Y. Subtalar arthroereisis combined with medial soft tissue reconstruction in treating pediatric flexible flatfoot with accessory navicular. *J Orthop Surg Res* 2023; **18**: 55 [PMID: 36658597 DOI: 10.1186/s13018-023-03542-w]
23 **Fang K**, Bi T, Hong A, Li X, Gong H, Li B, Li F, Wen J, Xiao S. Efficacy of modified kidner procedure combined with subtalar arthroereisis treating adolescent type 2 painful accessory navicular with flexible flatfoot. *Front Pediatr* 2023; **11**: 1258032 [PMID: 37675392 DOI: 10.3389/fped.2023.1258032]
24 **Lee JS**, Youn HK, Choi WJ, Lee JW. Comparison of clinical outcome of excision vs osteosynthesis in type II accessory navicular. *J Korean*

Foot Ankle Soc 2011; **15**: 72-78

25 **Jasiewicz B**, Potaczek T, Kacki W, Tesiorowski M, Lipik E. Results of simple excision technique in the surgical treatment of symptomatic accessory navicular bones. *Foot Ankle Surg* 2008; **14**: 57-61 [PMID: 19083616 DOI: 10.1016/j.fas.2007.12.002]

26 **Yang AA**, Hennrikus WL, Kwok E. Operative Outcomes for Accessory Navicular in Adolescents. *J Surg Orthop Adv* 2022; **31**: 53-55 [PMID: 35377309 DOI: 10.3113/JSOA.2022.0053]

27 **Pretell-Mazzini J**, Murphy RF, Sawyer JR, Spence DD, Warner WC, Beaty JH, Moisan A, Kelly DM. Surgical treatment of symptomatic accessory navicular in children and adolescents. *Am J Orthop (Belle Mead NJ)* 2014; **43**: 110-113

28 **Scott AT**, Sabesan VJ, Saluta JR, Wilson MA, Easley ME. Fusion versus excision of the symptomatic Type II accessory navicular: a prospective study. *Foot Ankle Int* 2009; **30**: 10-15 [PMID: 19176179 DOI: 10.3113/FAI.2009.0010]

29 **Kanatli U**, Yetkin H, Yalcin N. The relationship between accessory navicular and medial longitudinal arch: evaluation with a plantar pressure distribution measurement system. *Foot Ankle Int* 2003; **24**: 486-489 [PMID: 12854669 DOI: 10.1177/107110070302400606]

30 **Choi HJ**, Lee WC. Revision Surgery for Recurrent Pain after Excision of the Accessory Navicular and Relocation of the Tibialis Posterior Tendon. *Clin Orthop Surg* 2017; **9**: 232-238 [PMID: 28567228 DOI: 10.4055/cios.2017.9.2.232]

31 **Kim J**, Day J, Seilern Und Aspang J. Outcomes Following Revision Surgery After Failed Kidner Procedure for Painful Accessory Navicular. *Foot Ankle Int* 2020; **41**: 1493-1501 [PMID: 32762355 DOI: 10.1177/1071100720943843]

32 **Kim JM**, Jung SH, Park B, Moon CS, Lee KH. Surgical treatment of symptomatic accessory navicular in adolescent. *Korea Med* 2010; **14**: 36-40

33 **Luo Y**, Qi W, Wei M. Outcome of modified Kidner procedure with tendoscopy for the treatment of painful accessory navicular. *Zhongguo Gu Shang* 2021; **34**: 448-451

34 **Shurnas PS**, Sanders A. A novel approach to the symptomatic accessory navicular. *Tech Foot Ankle Surg* 2007; **6**: 195-200 [DOI: 10.1097/BTF.0b013e3180621ea6]

35 **Jang HS**, Park KH, Park HW. Comparison of outcomes of osteosynthesis in type II accessory navicular by variable fixation methods. *Foot Ankle Surg* 2017; **23**: 243-249 [PMID: 29202982 DOI: 10.1016/j.fas.2016.07.004]

36 **Kakihana M**, Tochigi Y, Yamazaki T, Ohashi M, Ozeki S. Suture anchor stabilization of symptomatic accessory navicular in adolescents: Clinical and radiographic outcomes. *J Orthop Surg (Hong Kong)* 2020; **28**: 2309499020918949 [PMID: 32400268 DOI: 10.1177/2309499020918949]

37 **Nakayama S**, Sugimoto K, Takakura Y, Tanaka Y, Kasanami R. Percutaneous drilling of symptomatic accessory navicular in young athletes. *Am J Sports Med* 2005; **33**: 531-535 [PMID: 15722276 DOI: 10.1177/0363546504270564]

38 **Lui TH**. Endoscopic Fusion of the Accessory Navicular Synchondrosis That Has No Diastasis. *Arthrosc Tech* 2017; **6**: e263-e267 [PMID: 28580240 DOI: 10.1016/j.eats.2016.09.029]

39 **Knupp M**, Hintermann B. Reconstruction in posttraumatic combined avulsion of an accessory navicular and the posterior tibial tendon. *Tech Foot Ankle Surg* 2005; **4**: 113-8 [DOI: 10.1097/01.btf.0000152576.94406.dc]

40 **Chung JW**, Chu IT. Outcome of fusion of a painful accessory navicular to the primary navicular. *Foot Ankle Int* 2009; **30**: 106-109 [PMID: 19254502 DOI: 10.3113/FAI-2009-0106]

41 **Fritz B**, Mauch M. Foot development in childhood and adoles cence. In: Luximon M, editor. Handbook of Footwear Design and Manufacture. Cambridge: Woodhead Publishing, 2013; 49-68

42 **Zeng G**, Hu X, Chen Y, Yang T, Qiu X, Li C, Song W. Comparison of outcomes of arthrodesis and reconstruction (advancement), posterior tibial tendon with excision of accessory tarsal navicular bone (Kidner procedure) in type 2 accessory navicula. *Foot Ankle Surg* 2020; **26**: 930-934 [PMID: 31959405 DOI: 10.1016/j.fas.2019.12.005]

43 **Sun N**, Chen J, Chen Z, Zeng C, Guo H. Clinical Outcomes of Fusion in Type II Accessory Naviculars With or Without Asymptomatic Flatfeet. *Foot Ankle Int* 2023; **44**: 139-147 [PMID: 36564915 DOI: 10.1177/10711007221140847]

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