

## Case Reports and Series

## Internal fixation for stress fracture of the anterior process of the calcaneus without calcaneonavicular coalition: A case report

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## ABSTRACT

Stress fracture of the anterior process of the calcaneus is a rare condition, especially without calcaneonavicular coalition. We present the case of a 13-year-old female basketball player who developed right ankle pain without obvious injury. There was tenderness on the right anterior inferior lateral malleolus, and a fracture of the anterior process of the calcaneus was confirmed by magnetic resonance imaging. There was tenderness on the right anterior-inferior malleolus and a fracture of the anterior process of the calcaneus was confirmed by magnetic resonance imaging. Since computed tomography showed sclerotic change around the fracture, we diagnosed it as a stress fracture. As the bone fragment was relatively large, internal fixation was performed. After confirming bony fusion, she was allowed to jog and return to playing basketball. No recurrence of symptoms was observed at the 1-year follow-up. The cause of the stress fracture in this case was considered to be an unusually long anterior process of the calcaneus; this should be suspected to guide intervention better in such cases.

## Introduction

The anterior process of the calcaneus (APC) is a saddle-shaped bony protuberance, located on the anterior portion of the calcaneus on the lateral side of the foot.<sup>1</sup> The APC is attached to the cuboid by an interosseous ligament and to the cuboid and navicular bones by a strong bifurcate ligament.<sup>2,3</sup> APC fractures are relatively rare, and are often undetected or misdiagnosed as ankle sprains. This type of fracture constitutes 3–23% of calcaneus fractures.<sup>2,4</sup> Although it has been presumed that 2–5% of all ankle sprains are associated with APC fractures,<sup>5,6</sup> Schepers et al. reported that most are missed on plain radiographs at emergency departments.<sup>7</sup> Degan et al. classified APC fractures into three types<sup>2</sup> based on the amount of fracture displacement and calcaneocuboid joint (CCJ) involvement; this classification is commonly used. Types I and II do not involve the CCJ, and are non-displaced and displaced avulsion fractures, respectively; type III is a displaced fracture with CCJ involvement.

Although stress fractures commonly occur in the foot and ankle, a stress fracture of the APC is considerably rare. To date, there have been only a few case reports on APC stress fractures.<sup>7–9</sup> (Table 1). To our knowledge, there have been no case reports on internal fixation treatment for an APC stress fracture without calcaneonavicular coalition (CNC). We report a case involving an APC stress fracture in a 13-year-old female basketball player. APC should be considered as a potential site of stress fractures for better guidance of treatment. CASE REPORT

A 13-year-old female basketball player developed right foot pain without obvious trauma. She had no significant past medical history nor trauma except minor ankle sprains during sports activity. She visited an orthopedic clinic in June 2018, where no abnormality was detected on plain radiographs (Fig. 1). Although she returned to playing basketball after conservative therapy, she still experienced ankle pain during sports activities and visited our outpatient clinic in February 2019. Examination at the initial visit showed tenderness on the anterior-inferior lateral malleolus of her right ankle. There was no swelling, local heat, or subcutaneous bleeding. She could walk freely without limping, and the range of motion of her right ankle was not restricted.

Since no abnormal findings except os trigonum could be found on plain radiographs (Fig. 2), magnetic resonance imaging (MRI) was performed for further assessment. The fat suppression images showed a low signal fracture line surrounded by high signal intensity in the APC (Fig. 3a,b); high signal periosteal edema was also identified around the APC. Although the fracture fragment did not demonstrate displacement, this fracture was classified as type III according to Degan's classification. The subsequent CT for preoperative evaluation showed sclerotic changes around the fracture line, and no findings to suggest CNC (Fig. 3c,d). Therefore, we diagnosed an APC stress fracture without CNC.

A long APC was observed when compared with the unaffected side, with the distance between the APC and the navicular bone being 4.8 mm on the affected side and 5.5 mm on the unaffected side. Since the bone fragment was relatively large, internal fixation was performed

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**Table 1**  
Review of stress fracture of the anterior process of the calcaneus

Investigator	Age	Sex	Sports	Fragment size*	Concomitant abnormality	Treatment
Nilsson LJ, Coetzee JC. (2006)	47 y	Male	Marathon	Type III	CNC	Internal fixation
Pearce CJ. et al. (2011)	30 y	Male	Rugby	Type III	CNC	Conservative
Taketomi S. et al. (2013)	14 y	Female	Basketball	Type III	TLAP	Multiple drilling
Present patient	13 y	Female	Basketball	Type III	TLAP	Internal fixation

\* Fragment size was classified by Degan's report (1), CNC: Calcaneonavicular coalition, TLAP: too long anterior process



**Fig. 1.** Plain X-ray obtained from the post-injury visit at another clinic in June 2018. a. anterior-posterior view, b. lateral view. There was no finding except os trigonum.

under general anesthesia in March 2019. The patient was placed in the supine position with a pillow under the ipsilateral buttock and a pneumatic tourniquet was applied to the thigh. The leg was internally rotated with the knee flexed, and the foot was kept in slight supination. A skin incision was made along the skin crease over the tip of the APC



**Fig. 2.** Plain X-ray at first visit at our outpatient clinic in February 2019. a. anterior-posterior view, b. lateral view. Although the lateral view showed fracture line and sclerotic change to the anterior process of the calcaneus (APC), the APC stress fracture was overlooked. anterior process of the calcaneus <sup>a</sup>

(Fig. 4a). The extensor digitorum longus was retracted medially, and the muscle belly of the extensor digitorum brevis was partially cut and retracted (Fig. 4b,c). By using the calcaneocuboid joint as a landmark, the fracture line was easily identified behind the joint (Fig. 4c). The bifurcate ligament was attached to the fragment, which was unstable. Since the surrounding bones showed sclerotic changes, they were refreshed by curettage and multiple drilling using 1.5 mm Kirschner wires. Thereafter, the fragment was fixed using two 20 mm ACUTRAK®2 Micro screws (Acumed, LLC., USA) and good compression was achieved (Figs. 4d, 5a). No synchondrosis or syndesmosis was found between the calcaneus and navicular bones during surgery. The wound was closed after repairing of the extensor digitorum brevis.

A cast was applied in the operation room. The postoperative therapy selected involved 4 weeks of non-weight bearing; this included 2 weeks each in a short leg cast and a cast with a heel. Range of motion exercises of the ankle and use of a partial weight bearing ankle brace commenced following cast removal. The pain disappeared one month after surgery and bony fusion was confirmed two months after surgery on tomosynthesis imaging (Fig. 5b,c). She was allowed to jog and play basketball from three and four months after surgery, respectively. At the final follow-up one year later, she was able to play basketball without any symptoms. Both, the patient and her parents provided informed consent for publication of the presented data.

## Discussion

Here, we report a rare stress fracture of the APC without a CNC. Unfortunately, this fracture had been overlooked on plain radiographs, but was detected on subsequent MRI and CT. CT also showed a comparatively long APC on both feet. Taketomi et al. also reported on an APC stress fracture without CNC, where they achieved bone fusion by drilling without internal fixation.<sup>9</sup> For our case, we decided that internal fixation should be performed, as the bone fragment was unstable and considerably large for fixation. Bone fusion was successfully obtained two months after surgery, and she could return to playing basketball without any symptoms.

Two patterns of onset have been reported for APC stress fractures. One is the association with CNC,<sup>7,8</sup> and the other is a too-long anterior process (TLAP).<sup>9</sup> In a foot with CNC, the related lack of normal motion may lead to increased pressure on the APC, resulting in a stress fracture. For this type of fracture, Pearce et al.<sup>8</sup> performed resection of the CNC and internal fixation of the APC, and Nilsson and Coetzee<sup>7</sup> selected non-surgical therapy, both with successful outcomes. TLAP is an anatomical abnormality, defined as a distance of less than 5 mm between the tip of the APC and the navicular.<sup>10</sup> The impingement of the TLAP between the talus and cuboid bones seemed to increase pressure on the APC and resulted in stress fracture.<sup>9</sup> In our case, the distance between the anterior process of the calcaneus and the navicular bone was 4.8 mm and 5.5 mm on the affected and unaffected side, respectively; this may have caused the stress fracture of the APC. Regardless of the cause, the APC stress fracture becomes a type III fracture because it is caused by repeated stress from the calcaneocuboid joint (Table 1).

To the best of our knowledge, this is the first report on internal fixation treatment for an APC stress fracture without CNC. Although there is no treatment algorithm for APC stress fractures, we followed the treatment algorithm proposed by Dhinsa et al. for traumatic fractures of the



**Fig. 3.** MRI and CT. a, b. MRI (STIR) showed low signal fracture line surrounded by bone marrow edema in the anterior process of the calcaneus (APC). c, d. CT also showed fracture line within the APC and sclerotic change. These MRI and CT findings were consistent with a stress fracture. Calcaneonavicular coalition was not found by these images. Fracture fragment occupied 42% of the surface of the joint.

APC.<sup>11</sup> According to their algorithm, a type III fracture as per the Degan's classification can be treated by open reduction and internal fixation; 13 of 17 patients in their cohort were able to return to sporting activity after acute open reduction and internal fixation, and 2 others reported satisfactory results. When surgery was delayed, 4 of the 22 patients remained symptomatic and 15 had satisfactory results.<sup>11</sup> If non-operative intervention is selected, the possibility of cartilage damage and subsequent arthrosis owing to displacement of the fragment into the CCJ should be considered.<sup>12</sup> This case report has certain limitations. The major limitation was that the possibility of a traumatic fracture could not be ruled out because of several episodes of minor ankle sprains. We had obtained a detailed medical history, and she did not mention any episodes of severe ankle sprains that made it difficult to walk. Another limitation was the short-term follow-up. Since this case has TLAP, the possibility of re-fracture remains.

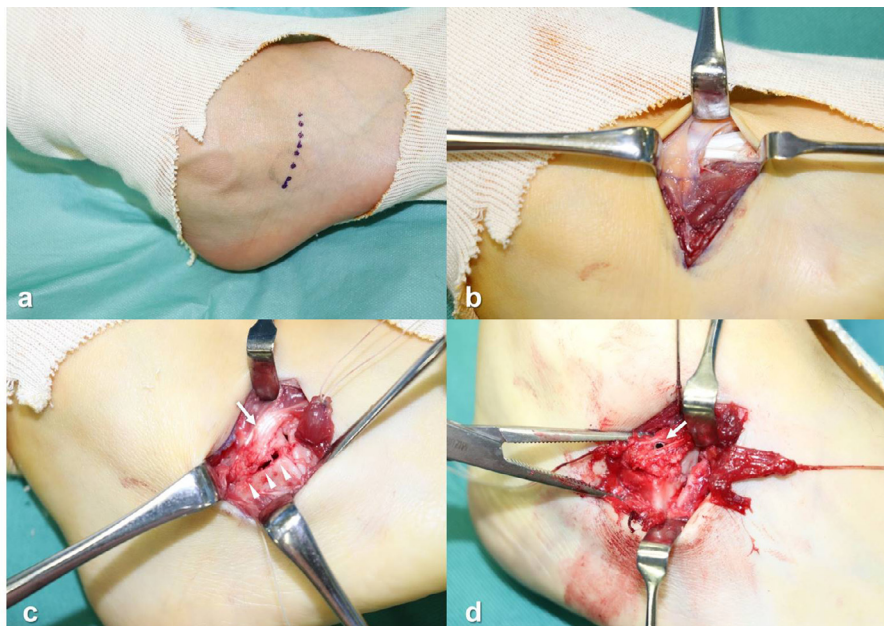
In conclusion, we present a case report of an APC stress fracture without CNC, in which we performed internal fixation. The cause of the stress fracture in this case was considered to be a TLAP of the calcaneus. An APC stress fracture with large fragment classified as type III is a candidate for internal fixation.

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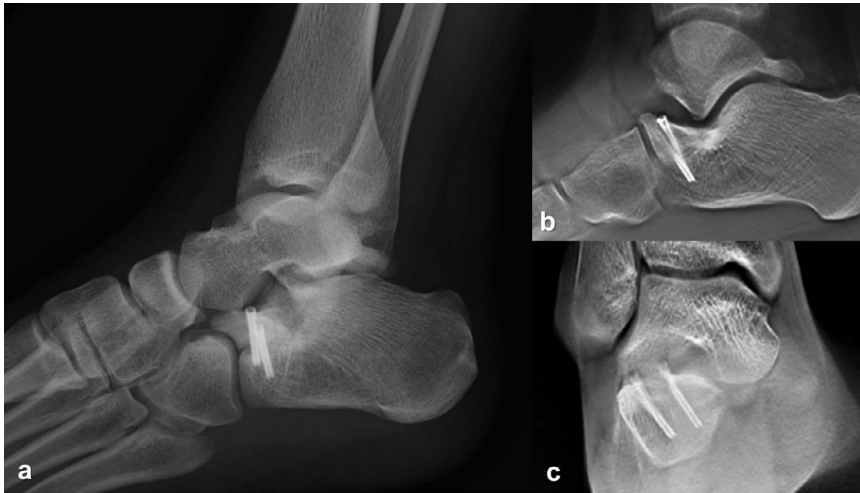
#### Declaration of competing interest

The authors declare that they have no competing interests.



**Fig. 4.** Osteosynthesis of anterior process of calcaneus stress fracture. a. Skin incision. b. The extensor digitorum longus and the muscle belly of the extensor digitorum brevis. c. The fracture line was easily identified (arrowheads). The bifurcate ligament attached to the fragment (arrows). Since the surrounding bones showed sclerotic change, they were refreshed by curettage and multiple drilling using 1.5 mm Kirschner wires. d. The fragment was fixed by 20 mm ACUTRAK®2 Micro screws (arrow).





**Fig. 5.** Plain X-ray and tomosynthesis imaging after surgery. a. X-ray (medial oblique view) just after surgery showed fracture line and sclerotic change clearly. b, c. Bone fusion was confirmed by tomosynthesis imaging two months after surgery.

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### Patient Informed Consent Statement

Complete informed consent was obtained from the patient for the publication of this study and accompanying images.

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