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Case Report

Avulsion fracture of anterior talofibular ligament from talus: A case report

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ABSTRACT

Anterior talofibular ligament (ATFL) injuries can occur in three different distinct patterns; rupture of the ligament as a pure soft tissue injury, an avulsion fracture at the ATFL's attachment to either the fibula or the talus. Although fibular avulsion fractures are common, avulsion fracture of ATFL from talus is extremely rare with a single previously reported case in the current literature. A 34-year-old female with ATFL talar avulsion fracture associated with medial malleolar fracture was presented to the emergency department. Fixation of the fragment resulted with excellent functional outcome without a residual instability. Besides more common injury patterns such as mid-substance ATFL rupture and ATFL fibular avulsion fracture, talar avulsion fracture pattern should also be kept in mind in a patient presented with lateral ankle sprain. When a fragment is seen on the ankle radiographs at the tip of fibula, previously described special oblique views should be performed to reveal the correct origin of the fragment.

1. Introduction

Ankle sprain is one of the most common musculoskeletal injuries presenting to emergency departments. A recent systematic review on epidemiological studies reported a pooled cumulative incidence rate of 11.55 per 1000 exposures for ankle sprains, and lateral ankle sprain was the most commonly observed type of ankle sprain [1]. The most common mechanism of ankle injury is inversion of the plantar-flexed foot which causes damage to the lateral ankle ligaments, particularly the anterior talofibular ligament (ATFL). ATFL injuries can occur in three distinct forms; (i) rupture of the ligament as a pure soft tissue injury, an avulsion fracture at the ATFL's attachment to the either (ii) fibula or (iii) talus [2,3].

The most common type of ATFL injury is pure ligamentous rupture followed by avulsion fracture from the tip of lateral malleolus [3]. Haraguchi et al. evaluated 169 ankle sprains and detected 44 (26%) avulsion fractures of ATFL in their series. Almost all fractures (43 out of 44) were avulsed from the lateral malleolus. The authors could not determine whether the fragment was avulsed from the lateral malleolus or from the talus because it was significantly displaced in one case [4]. Broström et al. evaluated 205 injuries to the ATFL with arthrography and detected 28 (14%) ATFL avulsion fractures from the lateral malleolus [5]. On the other hand, avulsion fracture from the talus is an extremely rare type of injury, and only one previous published case in the current literature was found [2]. Due to apparent rarity in the literature, this case is reported and discusses the differential diagnosis, radiographic findings and treatment of ATFL talar avulsion fracture.

2. Case report

A 34-year-old woman admitted to the emergency department immediately after she sustained an inversion ankle sprain. On presentation she was unable to weight bear and her ankle was severely swollen. Active and passive ankle movements were painful and restricted. There was tenderness both on medial and lateral malleolus. Neurovascular examination had normal findings. Direct radiographic examination of the ankle showed a displaced medial malleolar fracture and a bone fragment at the tip of fibula (Fig. 1a,b). Further, oblique foot radiographs delineated the fragment more clearly (Fig. 1c). In order to understand the pattern of injury, a further computerized tomography (CT) examination was performed. CT demonstrated that this fragment was avulsed from the talus at the attachment of ATFL (Fig. 2a–c). Because the patient had a displaced medial malleolar fracture and ankle instability, surgical fixation of the fractures was planned.

Under spinal anesthesia and tourniquet control, the medial malleolar fracture was fixed with two cannulated headless compression screws through standard incision and technique. On the anterolateral aspect of the ankle, over the distal fibular tip, another incision was made, and the bone fragment was dissected. During intraoperative examination, the fragment was found to be attached to the ATFL

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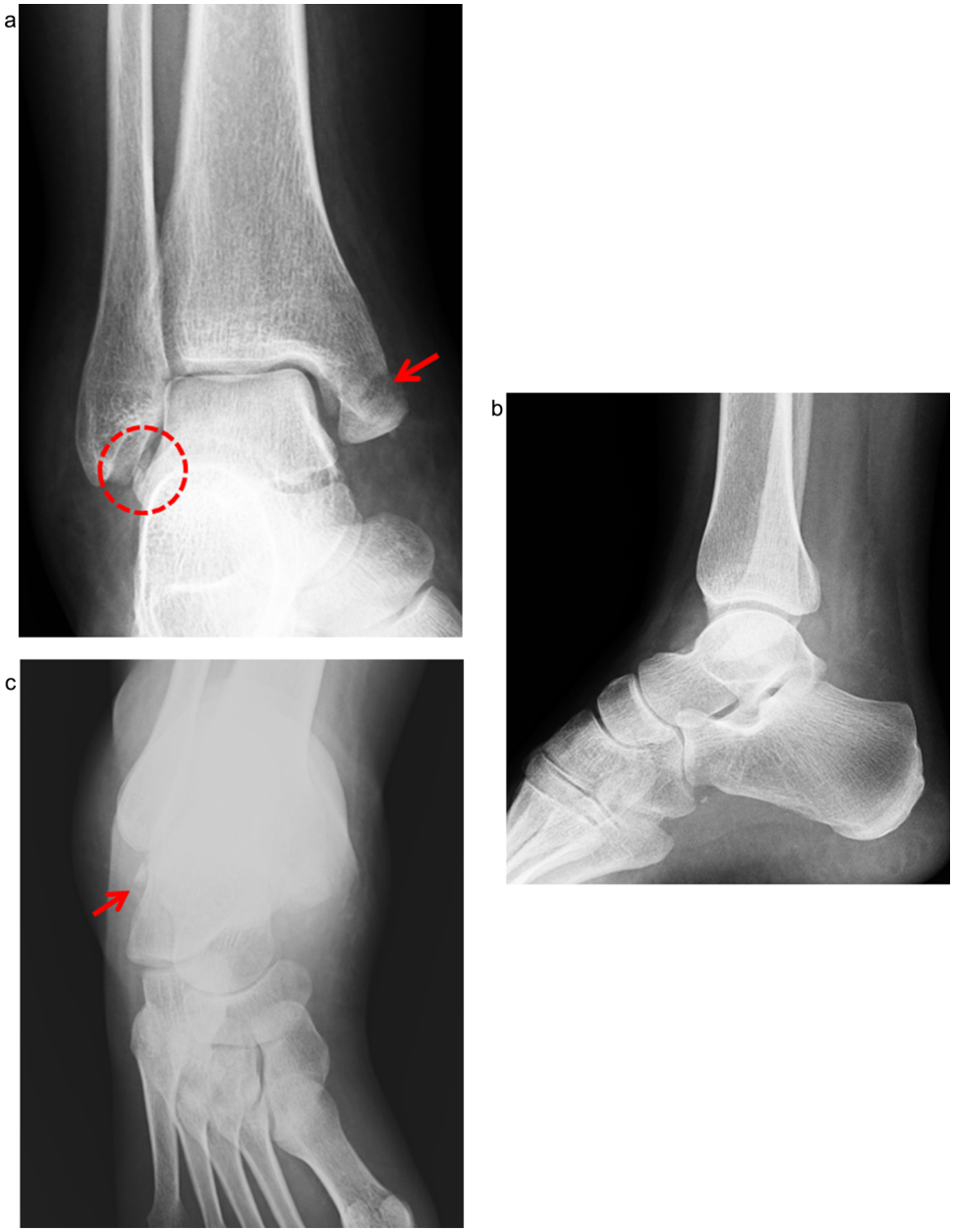

Fig. 1. Anteroposterior and lateral ankle radiographs (a, b) showed displaced medial malleolar fracture (arrow) and a fragment at the tip of fibula (dotted circle). Further oblique foot radiograph (c) taken in accordance with the description of Miyamoto et al. [2] revealed the fragment more clearly (arrow). However, the origin of the fragment was still obscure. (For interpretation of the references to color in this figure legend, the reader is referred to the web version of this article.)

(Fig. 3a,b). The fragment was fixed with a cannulated headless compression screw (Fig. 4a,b). The subcutaneous tissues and skin was closed properly. The postoperative period was uneventful and the patient was discharged on the first post-operative day.

A below knee cast was applied to the patient for four weeks. Afterwards, the cast was removed and weight-bearing was allowed as tolerated, and physical therapy program including ankle range of motion and strengthening was initiated. At the final follow-up, six months after the surgery, the patient was invited back to the hospital and final radiographic and clinical examination was performed. The patient was free of pain and returned back to her previous level of daily activity; the range of motion was normal compared with the contralateral side. The anterior drawer test had negative result. The American Orthopedic Foot and Ankle Society (AOFAS) score was 95. Final ankle radiographs showed union of the fracture.

3. Discussion

Conventional management of ankle sprains initially begin with rest, ice, elevation and compression followed by early functional rehabilitation and bracing. Although, complete recovery is achieved with conservative management in most patients, chronic complaints continue around one third of patients despite initial proper treatment [6]. These complaints are usually attributed to residual instability and unhealed cartilage injuries that occurred during the initial injury [7]. Residual instability may develop due to nonhealing of the injured ankle ligaments at proper strength and tension, or due to nonunion of avulsion fractures. For this reason, a free ossicle formed by avulsion fracture of ATFL from the distal fibula, also called as *os subfibulare*, is a common radiological finding in a majority of patients with chronic ankle instability [8]. Although, some authors claim that simple excision of these ossicles result with favorable outcomes, others recommend either

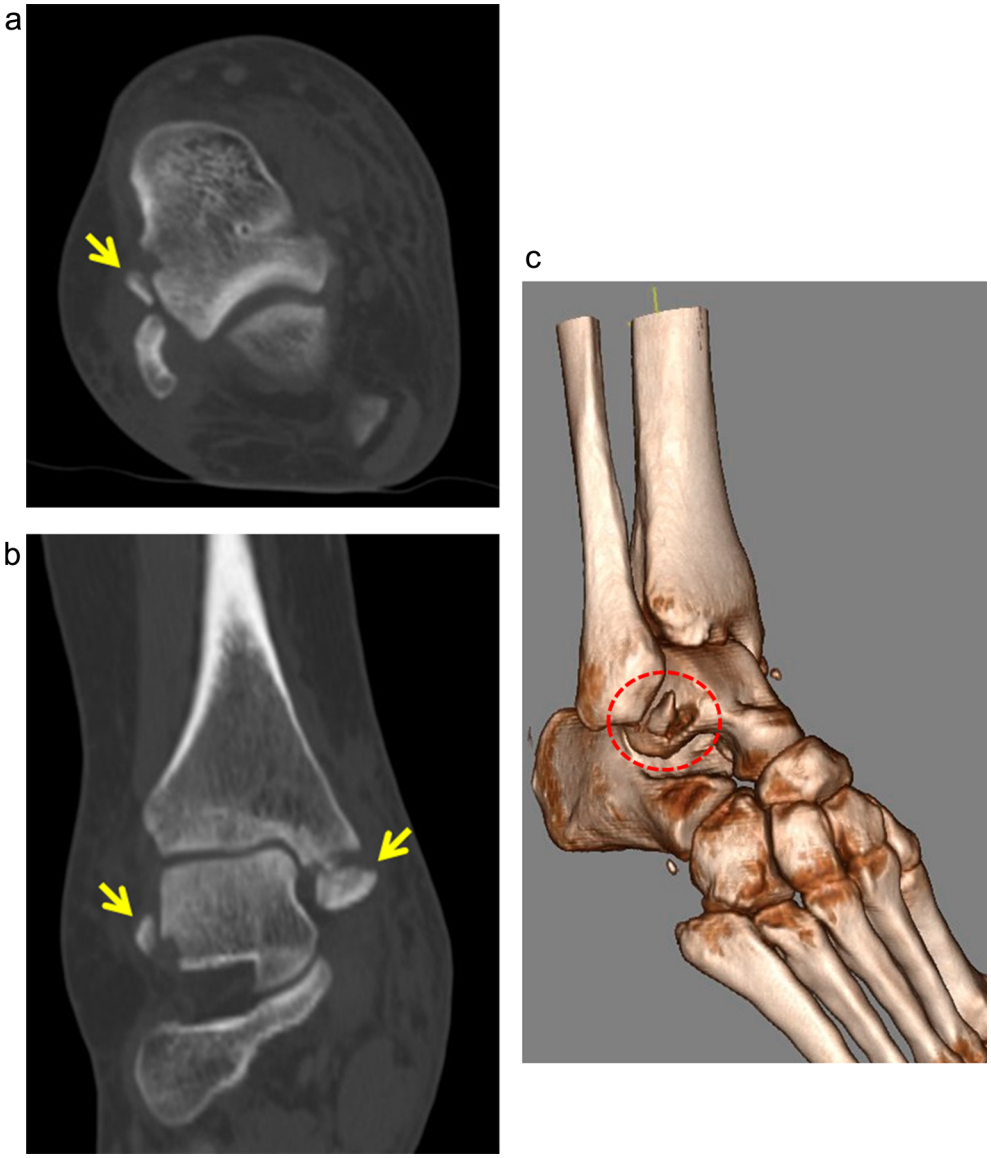

Fig. 2. Axial and coronal CT examination (a, b) demonstrated that the fragment was avulsed from the talus at the attachment of the ATFL (arrow). It was clearly visible in 3D CT appearance (dotted circle) (c). (For interpretation of the references to color in this figure legend, the reader is referred to the web version of this article.)

fixation and fusion, or repair of ATFL if excision is performed [8–10]. However, there is no information about the proper approach in case of an ATFL avulsion fracture from the talus in relevant literature. In the presented case, there was no residual instability, probably because of the union of the fragment to its anatomic location that provided sufficient tension of ATFL and function.

There are some biomechanical and histological studies that attempted to reveal the mechanisms of injury of the ATFL. In a cadaver study performed by Pierre et al., ATFL was dissected and left alone, thereafter the talus and fibula were separated from each by application of gradual load parallel to its fibers. As an interesting finding, the most common injury pattern was the avulsion fracture from the talus followed by mid-substance rupture of the ligament [11]. However, this experimental set-up may not actually reflect the real conditions because it is known that not only the distraction forces but also the shear forces play role in the injury of ATFL [12]. On the other hand, histological studies suggest that talar attachment of ATFL is stronger than the fibular attachment and the ligament itself. Kumai et al. showed that bone density was greater at the talar attachment than at the fibular enthesis, and stress was dissipated away from the talar enthesis by the 'wraparound' fibrocartilaginous character of the ligament near the talar articular facet. Therefore, the authors proposed that talar avulsion fractures are less likely to occur, based on the reasons listed above [13]. These conflicting results suggest that there are two possibilities. First, if the ATFL avulsion fractures are that much frequent, they are either missed or mixed with the fibular avulsion fractures due to similar radiological findings. Second, this type of injury occurs rarely in real settings.

There are four different entities that should be kept in mind when a bony fragment was detected at the tip of fibula on anteroposterior ankle radiographs, namely fracture of lateral process of talus (*snowboarder's fracture*) (Fig. 5a), os talus secundarius (Fig. 5b), ATFL fibular avulsion fracture (*os subfibulare*) (Fig. 5c), and ATFL talar avulsion fracture (Fig. 5d). Os subfibulare and ATFL fibular avulsion fractures (particularly in chronic presentation) cannot be distinguished from each other easily due to similar radiological findings. In fact, there is no consensus about the origin of these ossicles. Some authors have suggested that os subfibulare is not a true sesamoid bone but rather that it is an old non-united avulsion fracture of the lateral malleolus resulting from the traction of the anterior talofibular ligament [14,15]. However, some

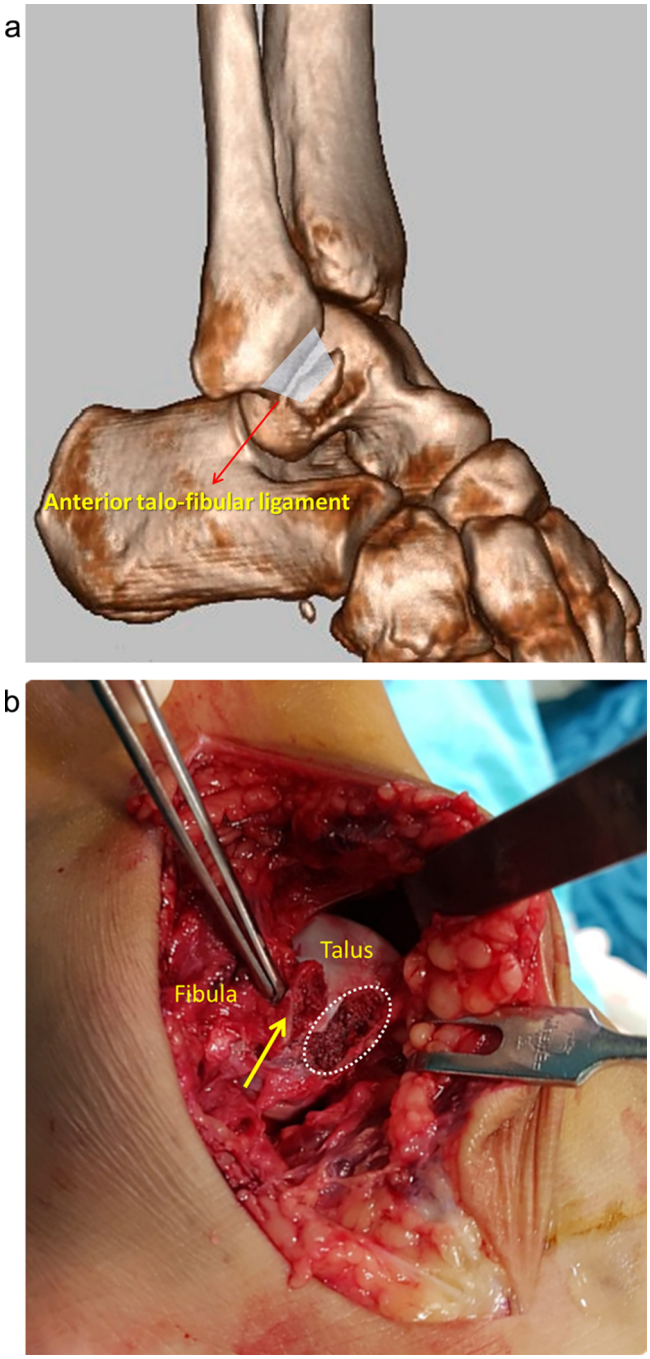

Fig. 3. The relationship between the fragment and ATFL on 3D CT image (a). Intraoperative appearance of the fragment and the ATFL. Arrow shows the fragment and the dotted circle shows its bed on the talus (b). (For interpretation of the references to color in this figure legend, the reader is referred to the web version of this article.)

authors believe that it is a true sesamoid bone formed by an accessory ossification center [16,17]. Os talus secundarius is another rare accessory ossicle located at the lateral aspect of the talus just anterior to the lateral malleolus. There are only few cases reports and detailed information on this rare entity. Similar to the origin of os subfibulare, Kose et al. discussed that os talus secundarius may be an old ununited ATFL talar avulsion fracture [18]. Fracture of lateral process of talus is also a rare fracture and often missed on AP ankle radiographs in patients who sustained an ankle sprain. The fragment in the lateral process fracture is a little bit distally located, because the fragment involves the subtalar joint [19]. Finally, ATFL acute talar avulsion

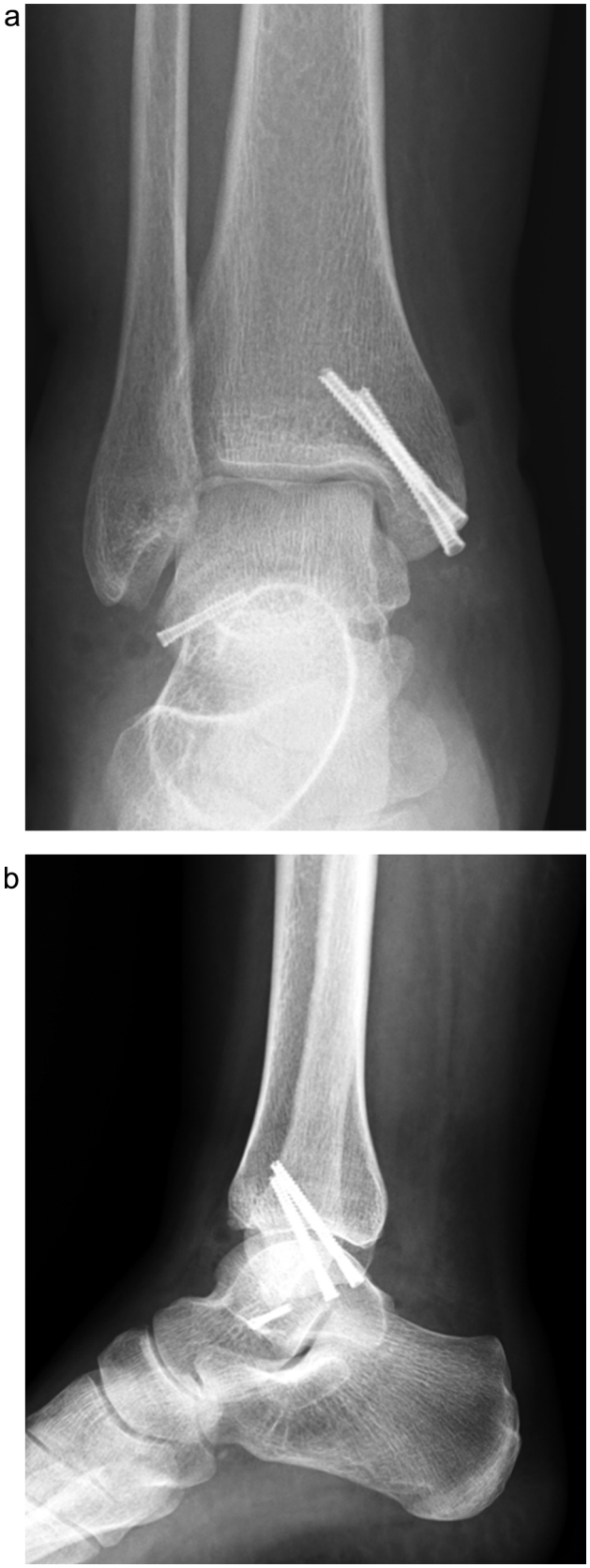

Fig. 4. Postoperative AP (a) and lateral (b) radiographs showing the fixation of both medial malleolar and ATFL talar avulsion fractures with headless compression screws.

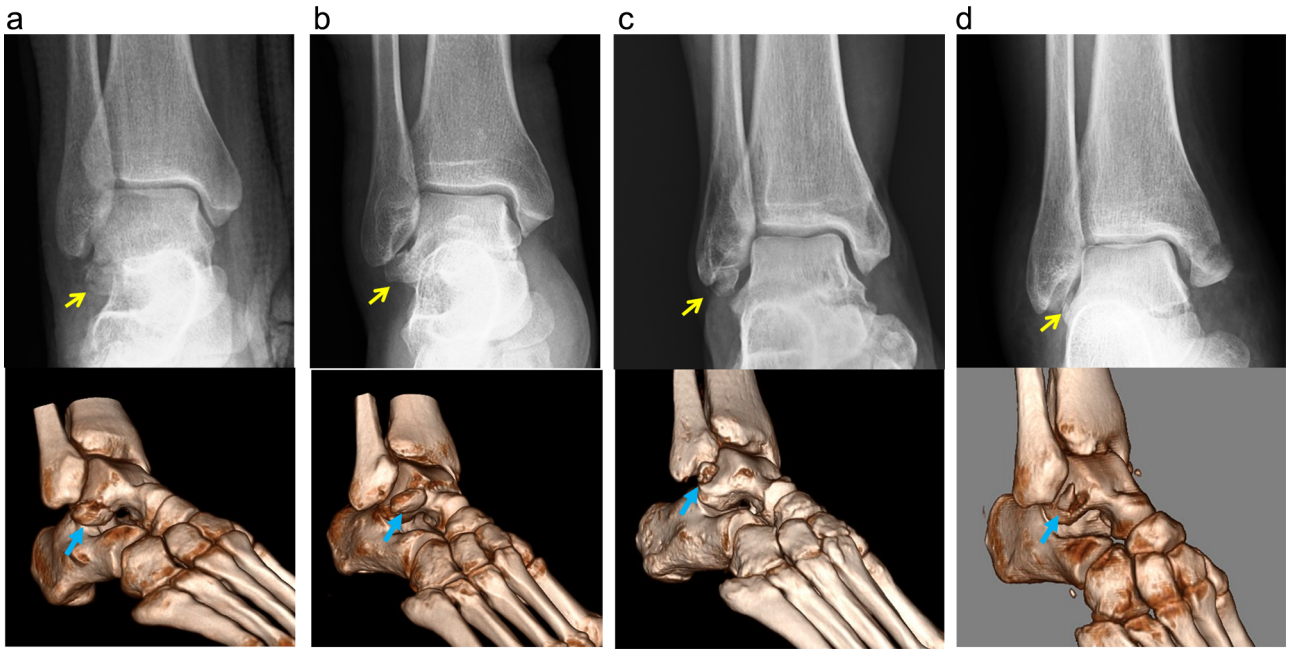

Fig. 5. Differential diagnosis of fragments seen at the tip of lateral malleolus on radiographs. Each figure section shows the x-ray and the 3D CT image of different patients. Arrows show the fragments on radiographs, and the same fragments on 3D CT images. (a) 28-year-old male patient with fracture of lateral process of talus. (b) 42-year-old male patient with os talus secundarius. (c) 22-year-old male patient with Os subfibulare or ATFL fibular avulsion fracture. (d) 34-year-old female patient with ATFL talar avulsion fracture (current case). Please note the similarities in both direct radiographic and 3D CT images in each different clinical entity. (For interpretation of the references to color in this figure legend, the reader is referred to the web version of this article.)

fractures may be seen as a bony fragment in this region as seen in this presented case. High level of suspicion, careful evaluation of the radiographs and through knowledge about all these entities will help physicians to reach correct diagnosis.

Unfortunately, these injuries cannot be clearly identified in standard AP and lateral ankle radiographs. For this reason, special radiographic views have been described for the detection of these fractures. Miyamota et al. described an oblique radiographic view that is specially used for ATFL talar avulsion fractures, and a presented a case with an ATFL talar avulsion fracture using this imaging technique [2]. They associated the infrequent identification of this fracture with the less chance of visibility on standard radiographs. Haraguchi et al. also described another radiographic view that could be used in the detection of ATFL fibular avulsion fractures [20]. Both of these special views consist of foot oblique radiographs in positions similar to each other. In addition to these direct radiographic methods, CT has an important role in discrimination of possible differential diagnosis. In particular, it provides a distinct advantage over direct radiography about the origin of the fracture fragment. Although exposure to radiation is high with CT, its use is recommended to reach the correct diagnosis in case of suspicion.

In conclusion, ATFL talar avulsion fractures are rarely reported in the current literature, and unfortunately the management of these fractures are not clear. Because of the fact that they are equivalent to total ligament ruptures, these injuries should be cautiously approached. In the presented case, fixation of the fragment resulted with excellent functional outcome without a residual instability. Besides more common injury patterns such as mid-substance ATFL rupture and ATFL fibular avulsion fracture, talar avulsion fracture pattern should also be kept in mind in a patient presented with lateral ankle sprain. When a fragment is seen on the ankle radiographs at the tip of fibula, previously described special oblique views should be performed to reveal the correct origin of the fragment. Although it is not possible to withdraw sharp clinical implications based on a single case, the authors believe that fixation of these fractures, if the fragment is large enough for screw fixation, may prevent the residual instability.

Conflicts of interest statement

The authors whose names are listed immediately below certify that they have NO affiliations with or involvement in any organization or entity with any financial interest (such as honoraria; educational grants; participation in speakers' bureaus; membership, employment, consultancies, stock ownership, or other equity interest; and expert testimony or patent-licensing arrangements), or non-financial interest (such as personal or professional relationships, affiliations, knowledge or beliefs) in the subject matter or materials discussed in this manuscript.

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Consent

Informed consent has been taken from the patient for the publication of the clinical and radiographic data.

References

[1] Doherty C, Delahunt E, Caulfield B, Hertel J, Ryan J, Bleakley C. The incidence and prevalence of ankle sprain injury: a systematic review and meta-analysis of prospective epidemiological studies. Sports Med 2014;44:123–40. https://doi.org/10.1007/s40279-013-0102-5.

[2] Miyamoto W, Takao M, Nishiguchi K, Uchio Y. Technique tip: a radiographic projection for an avulsion fracture of the talar attachment of the anterior talofibular ligament. Foot Ankle Int 2008;29:435–7. https://doi.org/10.3113/FAI.2008.0435.

[3] Kemmochi M, Sasaki S, Fujisaki K, Oguri Y, Kotani A, Ichimura S. A new classification of anterior talofibular ligament injuries based on ultrasonography findings. J Orthop Sci 2016;21:770–8. https://doi.org/10.1016/j.jos.2016.06.011.

[4] Haraguchi N, Toga H, Shiba N, Kato F. Avulsion fracture of the lateral ankle ligament complex in severe inversion injury: incidence and clinical outcome. Am J Sports Med 2007;35:1144–52. https://doi.org/10.1177/0363546507299531.

[5] Broström L. Sprained ankles. 3. Clinical observations in recent ligament ruptures. Acta Chir Scand 1965;130:560–9.

[6] van Rijn RM, van Os AG, Bernsen RMD, Luijsterburg PA, Koes BW, Bierma-Zeinstra

SMA. What is the clinical course of acute ankle sprains? A systematic literature review. Am J Med 2008;121. https://doi.org/10.1016/j.amjmed.2007.11.018. 324–331. e6.
[7] Löfvenberg R, Kärrholm J, Lund B. The outcome of nonoperated patients with chronic lateral instability of the ankle: a 20-year follow-up study. Foot Ankle Int 1994;15:165–9. https://doi.org/10.1177/107110079401500401.
[8] Han SH, Choi WJ, Kim S, Kim S-J, Lee JW. Ossicles associated with chronic pain around the malleoli of the ankle. J Bone Joint Surg Br 2008;90:1049–54. https://doi.org/10.1302/0301-620X.90B8.20331.
[9] Monden S, Hasegawa A, Hio N, Taki M, Noguchi H. Arthroscopic excision of separated ossicles of the lateral malleolus. J Orthop Sci 2013;18:733–9. https://doi.org/10.1007/s00776-013-0412-3.
[10] Kim BS, Choi WJ, Kim YS, Lee JW. The effect of an ossicle of the lateral malleolus on ligament reconstruction of chronic lateral ankle instability. Foot Ankle Int 2010;31:191–6. https://doi.org/10.3113/FAI.2010.0191.
[11] St. Pierre RK, Rosen J, Whitesides TE, Szczukowski M, Fleming LL, Hutton WC. The tensile strength of the anterior talofibular ligament. Foot Ankle 1983;4:83–5. https://doi.org/10.1177/107110078300400208.
[12] Attarian DE, McCrackin HJ, DeVito DP, McElhaney JH, Garrett WE. Biomechanical characteristics of human ankle ligaments. Foot Ankle 1985;6:54–8.
[13] Kumai T, Takakura Y, Rufai A, Milz S, Benjamin M. The functional anatomy of the human anterior talofibular ligament in relation to ankle sprains. J Anat 2002;200:457–65.
[14] Berg EE. The symptomatic os subfibulare. Avulsion fracture of the fibula associated with recurrent instability of the ankle. J Bone Joint Surg Am 1991;73:1251–4.
[15] Ferran J, Blanc T. Os subfibulare in children secondary to an osteochondral fracture. J Radiol 2001;82:577–9.
[16] Champagne IM, Cook DL, Kestner SC, Pontisso JA, Siesel KJ. Os subfibulare. Investigation of an accessory bone. J Am Podiatr Med Assoc 1999;89:520–4. https://doi.org/10.7547/87507315-89-10-520.
[17] Kono T, Ochi M, Takao M, Naito K, Uchio Y, Oae K. Symptomatic os subfibulare caused by accessory ossification: a case report. Clin Orthop Relat Res 2002:197–200.
[18] Kose O, May H, Acar B, Unal M. Symptomatic os talus secundarius: a case report and review of the literature. Skeletal Radiol 2018;47:553–62. https://doi.org/10.1007/s00256-017-2803-6.
[19] Tinner C, Sommer C. Fractures of the lateral process of the talus. Foot Ankle Clin 2018;23:375–95. https://doi.org/10.1016/j.fcl.2018.04.009.
[20] Haraguchi N, Kato F, Hayashi H. New radiographic projections for avulsion fractures of the lateral malleolus. J Bone Joint Surg Br 1998;80:684–8.