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CASE REPORT

Ultrasonography for the identification of deltoid ligament rupture: a case report

Uso de ultrasonografía para la identificación de ruptura de ligamento deltoideo: reporte de un caso

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Abstract

Introduction: Ankle ligament injuries are quite common. Signs such as ecchymosis, edema and pain are taken into account to assess the integrity of the deltoid ligament; however, they are not reliable for diagnosing this injury. Accurate and rapid diagnostic tests such as ultrasonography are useful to establish an adequate treatment and provide early rehabilitation, so its use is key to prevent the development of chronic ligament insufficiency and instability.
Case presentation: A 37-year-old woman who suffered left inversion ankle sprain after falling from her height was admitted to the emergency department of a quaternary care center in Cali (Colombia) with pain, edema, and medial and lateral ecchymosis. Anteroposterior and lateral X-rays of the ankle showed a supination-external rotation type IV (SER IV) fracture according to the Lauge-Hansen classification. Nuclear magnetic resonance was performed, detecting a complete rupture of the deltoid ligament. Following ultrasonographic confirmation of the diagnosis, the patient underwent surgical treatment (open reduction and internal fixation of the lateral malleolus and reconstruction of the deltoid ligament), showing a satisfactory recovery in terms of pain and function at follow-up.
Conclusion: Compared to MRI, ultrasonography is a low-cost tool that enables rapid confirmation of the presence of injuries, which can help define appropriate treatment in a timely manner.
Keywords: Ankle fractures; Lateral ligament, ankle; Ultrasonography; Magnetic resonance imaging (MeSH).

Resumen

Introducción. Las lesiones de los ligamentos del tobillo son comunes. Para evaluar la integridad del ligamento deltoideo se consideran signos como equimosis, edema y dolor; sin embargo, estos no son confiables para diagnosticar esta lesión. Las pruebas diagnósticas precisas y rápidas como la ultrasonografía son útiles para definir un tratamiento adecuado y favorecer la rehabilitación temprana, por lo que su uso es clave para prevenir el desarrollo de insuficiencia ligamentaria crónica e inestabilidad.
Presentación del caso. Mujer de 37 años que sufrió inversión forzada del tobillo izquierdo en una caída de altura, quien ingresó al servicio de urgencias de un hospital de cuarto nivel de atención de Cali (Colombia) con dolor, edema y equimosis medial y lateral. Se realizaron radiografías anteroposterior y lateral de tobillo en las que se evidenció lesión tipo supinación-rotación externa IV según la clasificación de Lauge-Haussen. Se realizó una resonancia magnética nuclear, en la que se observó ruptura completa del ligamento deltoideo. Una vez confirmado el diagnóstico mediante una ultrasonografía, la paciente recibió manejo quirúrgico (reducción abierta y fijación interna del maléolo lateral y reconstrucción del ligamento deltoideo), mostrando una recuperación satisfactoria en términos de dolor y funcionalidad en el seguimiento.
Conclusión. En comparación con la resonancia magnética, la ultrasonografía es un estudio de imagen de bajo costo que permite confirmar de forma rápida la presencia de lesiones, lo cual puede ayudar a definir un tratamiento adecuado de manera oportuna.
Palabras clave: Fracturas de tobillo; Ligamentos laterales del tobillo; Ultrasonografía; Imagen por resonancia magnética (DeCS).

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Introduction

Ankle ligament injuries are common in sports and recreational activities, as it is estimated that one sprain occurs per day for every 10 000 people.[1,2] For many years, the diagnosis and treatment of this type of injury focused on lateral injuries; however, medial ligament involvement occurs more frequently in ankle fractures,[3] so they could be misdiagnosed and undertreated. It is now recognized that the deltoid ligament is the main medial stabilizer of the ankle and prevents lateral and external rotational displacement of the talus.[3,4]

A recent study reported that deltoid ligament rupture occurs in 40% of ankle fractures and is a factor influencing the healing and functional outcomes of patients with these injuries.[5] In addition, it has been described that there is a strong relationship between deltoid ligament rupture and the type of fracture, mainly in those classified as 44B2.1 and 44B2.3.[6] In this regard, timely identification of deltoid injuries in ankle fractures is highly important, as it has implications for patient prognosis. On the other hand, lateral malleolus injuries with deltoid ligament rupture are unstable injuries and stable internal fixation of the fibula is required in most affected patients.

Chronic injury to the deltoid ligament results in claudication and anteromedial laxity, as well as ankle and rearfoot valgus. This may lead to advanced stages of posterior tibial tendon dysfunction or varus ankle osteoarthritis, resulting in deltoid ligament insufficiency.[5,7] Currently, due to the increase in the number of patients requiring ankle joint replacement, the presence of ligament insufficiencies that complicate the performance of this procedure is becoming more and more common, so primary repair of the ligament injury and the fracture during the same surgical intervention has increased in these patients.

Regarding post-traumatic ankle osteoarthritis, Horisberger *et al.*,[8] in a study of 141 individuals, reported that 53.2% presented with this condition.

Surgical management of deltoid ligament injuries is indicated when bimalleolar or equivalent bimalleolar ankle fractures are present, particularly in cases where the mortise remains open after anatomic fixation of the lateral malleolar fracture.[3,9] Acute deltoid ligament repair techniques include terminal end-to-end repair, fixation through bone tunnels or with suture anchors, and the use of autografts and/or allografts.[3,9]

Regardless of the severity of the fracture of the fibula, a rupture of the superficial portion of this bone does not alter the medial clear space (MCS) if the deep layer of the deltoid ligament is intact. However, simultaneous rupture of the superficial and deep portions of the deltoid ligament may result in increased MCS, which requires targeted treatment.[10]

According to McConnell *et al.* ,[11] physical examination findings such as pain, edema and ecchymosis on the medial aspect of the ankle are of little use in the detection of deltoid ligament rupture. With regard to its identification by imaging studies, it has been described that the following factors may influence the images obtained in ankle X-rays (both in neutral and stress positions): the amount of force applied to the joint during the X-ray, the patient's cooperation depending on their level of pain, the presence of muscle spasm, and the amount of soft-tissue edema.[7,12]

In the 1960s, Sherwin Staples referred to ankle ligament injuries as "invisible injuries" because they could go unnoticed on X-rays.[6,13-15] Currently, ultrasonography is successfully used in the medical field as a non-invasive, quick and painless diagnostic procedure that has no side effects or contraindications. In this context, ultrasonography

has been used in the diagnosis of lateral ankle ligament injuries; however, according to our literature review, there are few reports of its use in patients with deltoid ligament injuries and ankle fractures.[6,13-15]

The study of ankle ligament injuries with ultrasonography has shown advantages since it allows diagnosis in real time, has a low cost, and avoids exposing patients to radiation. A study conducted by Henari *et al.*[16] in patients with deltoid ligament involvement reported that the ultrasonography technique had a sensitivity and specificity of 100% for the detection of this injury, while simple X-rays had a sensitivity and specificity of 57.1% and 60%, respectively. Moreover, Park *et al.*[17] reported that ultrasonography is a highly effective diagnostic study with up to 100% sensitivity, 85% specificity, and 90% accuracy. These results position ultrasonography as an important diagnostic tool for deltoid ligament ruptures.

Therefore, besides being a non-invasive, fast, affordable and easily accessible technique in operating rooms, ultrasonography favors the evaluation and diagnosis of patients in whom it is not possible to perform a nuclear magnetic resonance, such as polytraumatized and unconscious patients who require intraoperative assessment, or those with contraindications for such imaging tests (for example, patients with local metallic implants).[18]

On the other hand, although nuclear magnetic resonance allows direct visualization of the deltoid ligament, which makes it possible to evaluate the ankle ligaments and note joint abnormalities, joint effusion and bone edema, this study does not allow evaluation of joint stability since the image is static. Magnetic resonance imaging can also be used to evaluate the superficial and deep components of the ligament separately, but its cost and availability in Colombian hospitals limits its use.[10,14,19]

Ultrasonography provides excellent delineation of the normal ankle ligament anatomy and can be routinely used in emergency departments and operating rooms to assess ligament integrity. According to the Hinterman's classification, deltoid ligament rupture can be divided into the following types: I (proximal ligament tear/avulsion), II (mid substance tear), and III (distal ligament tear/avulsion and spring ligament).[20]

In view of the above, this article reports the case of a woman with a ruptured deltoid ligament in whom ultrasonography was used for diagnosis in real time.

Case presentation

37-year-old woman who suffered forced inversion of the left ankle caused by trauma due to a fall from her own height during landing on a paragliding flight. The patient was admitted to the emergency department of a quaternary care hospital in Cali (Colombia) with signs and symptoms of swelling and acute pain in the left ankle for one day, with no relevant clinical history. The patient reported that she had suffered an ipsilateral tibia fracture 10 years earlier, which occurred while practicing the same sport and was treated surgically with a good outcome. On physical examination, the woman presented pain and signs of edema in the medial and lateral malleolus, medial and lateral ecchymosis, deformity and inability to rest on the left foot, as well as blisters on the medial aspect of the ankle and preserved distal pulses and sensitivity (Figure 1).

Figure 1. Medial surface of the patient's left ankle on admission to the emergency department.
Source: Image obtained during the clinical management of the patient.

Considering the foregoing, anteroposterior and lateral X-rays of the ankle were taken, in which isolated fracture of the lateral malleolus and enlargement of the medial clear space were observed (Figure 2).

Figure 2. Lateral and anteroposterior X-rays of the left ankle.
Source: Image obtained during the clinical management of the patient.

Based on the X-ray studies, the injury was categorized as a supination-external rotation stage 4 fracture according to the Lauge-Hansen classification.[21] Due to the increase in the MCS and the clinical characteristics of the fracture, the presence of a rupture of the deltoid ligament was suspected, so stress X-rays were indicated; however, it was not possible to perform them due to the intense pain reported by the patient. Therefore, on the first day of admission to the emergency room, an MRI was performed, which showed a complete rupture of the deltoid ligament (Figure 3).

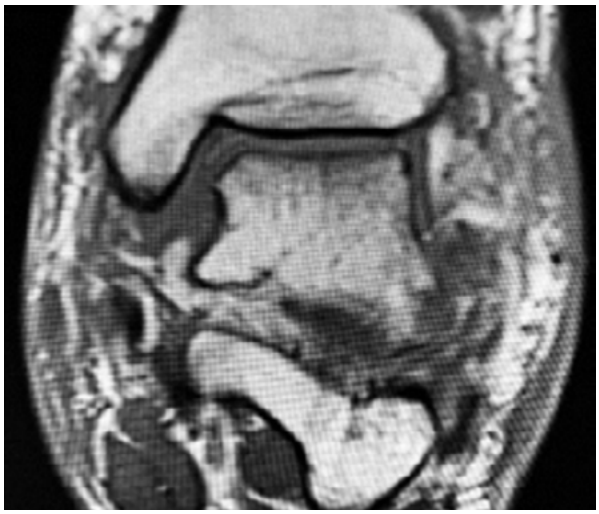

Figure 3. Nuclear magnetic resonance imaging showing rupture of the deltoid ligament.
Source: Image obtained during the clinical management of the patient.

In order to manage the affected soft tissues and avoid further bone and vascular involvement, the joint was immobilized using a hinged ankle foot orthosis on the left lower limb and the patient was hospitalized to treat pain and edema. On the ninth day of hospitalization, it was decided that the best therapeutic option was surgery, so the patient was taken to open reduction and osteosynthesis of the lateral malleolus with possible repair of the medial structures, and regional anesthesia (neuraxial blockade) was administered.

Prior to the procedure, an ultrasound was performed placing the patient in supine decubitus with the ankle in neutral position and in different degrees of dorsiflexion and external rotation (5°-10°) and using a transducer between the medial malleolus and the talus (Figure 4A). The ultrasound showed a rupture of the deltoid ligament (Figure 4B), which corroborated the imaging findings observed in the nuclear magnetic resonance. This result was further confirmed through the talar tilt test[22] (Figure 5A). It should be noted that, in order to show the imaging pattern of an undamaged deltoid ligament, a comparative ultrasound was performed in a person without the presence or history of ankle trauma (Figure 5).

Figure 4. Ultrasound of the left ankle showing deltoid ligament rupture. A. Performance of the imaging test. B. Imaging findings.
Source: Image obtained during the clinical management of the patient.

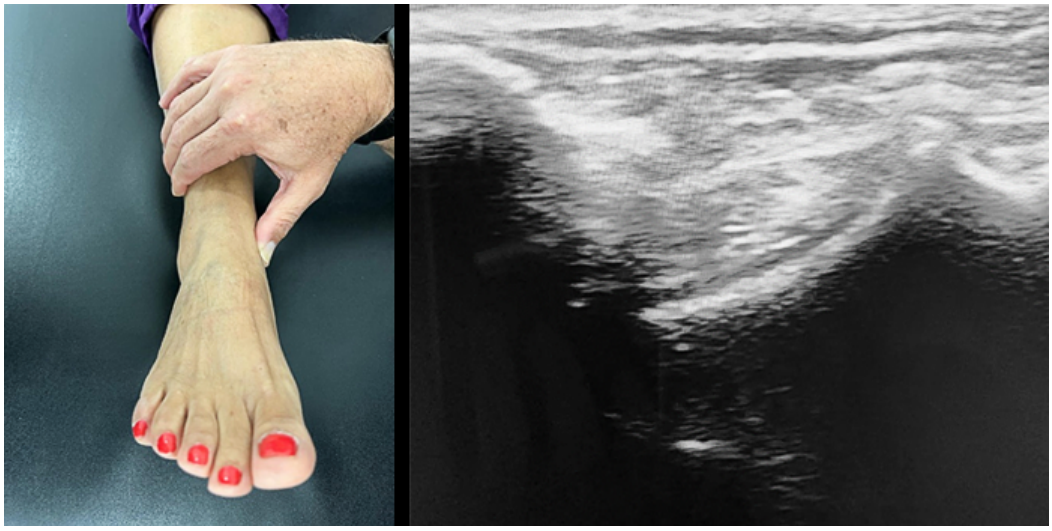

Figure 5. Healthy deltoid ligament. A. Talar tilt test. B. Ultrasound of the ankle.
Source: Image obtained during the clinical management of the patient.

Considering the clinical and imaging findings, open reduction surgery and internal fixation of the lateral malleolus and reconstruction of the left ankle deltoid ligament was performed immediately after the ultrasound, as described below. First, through a lateral surgical approach, the lateral malleolus was internally fixed with a plate. Then, the medial malleolus was approached medially through an incision that extended over the anatomical area of the deltoid ligament. Once the mid substance of the deltoid ligament was reached, the saphenous nerve was spared, and the ligament was separated from its malleolar insertion site. Ligament reconstruction was performed using two suture anchors (2.7 millimeters [mm]) that were placed in the center of the medial malleolus (Figure 6). Finally, the stability of the ankle was checked intraoperatively, with a satisfactory result (Figure 6).

Figure 6. Open reduction and internal fixation of the lateral malleolus and reconstruction of the left ankle deltoid ligament. A. Lateral malleolus fixation with plate. B. Stabilization of the injury with suture anchors of the medial malleolus.
Source: Image obtained during the clinical management of the patient.

The patient was discharged two days after the surgery. Postoperative follow-up visits at one week, one month, two months, three months, six months, one year and two years were scheduled. During the last postoperative follow-up, the patient presented with a pain score of 1 on the visual analog scale and a score of 95 on the American Orthopaedic Foot and Ankle Society (AOFAS) Functional Foot and Ankle Assessment Scale (FASAS). Likewise, the patient reported that she performed sports activities without any limitations, although it was difficult for her to run long distances.

Discussion

Ankle fractures usually involve bone and ligament injuries.[2,7,15,23] It has been described that the deltoid ligament is involved in up to 40% of ankle fractures,[2,7,23] which were also observed in the patient in this article. The present case demonstrates the importance of identifying deltoid ligament ruptures in patients with lateral malleolus fractures, as well as the use of ultrasonography to determine the presence of these injuries since it is a fast, low-cost method of confirmation in emergency departments and useful in cases in which it is not possible to perform a nuclear magnetic resonance imaging scan.

The deltoid ligament is the most important medial dynamic restrictor of the ankle and has a multifascicular morphology that expands from the medial malleolus towards the talus, calcaneus and navicular bones, taking on a triangular shape. Therefore, this ligament is fundamental in the normal biomechanics of the ankle, as it stabilizes the talus against the medial malleolus.[2,7,23] On the other hand, although clinical signs such as ecchymosis, edema and pain are currently used to assess the integrity of the medial structures of the foot, some studies report that these signs are not only seen in patients with deltoid ligament rupture.[24]

The three most common and distinctive mechanisms of injury in deltoid ligament rupture are pronation-abduction, pronation-external rotation and supination-external rotation, although there may be combinations. It has been reported that approximately 80% of ankle fractures are secondary to supination-external rotation forces and are classified into four stages depending on the severity and energy of the trauma.[2,3,6,24]

A stage 4 supination-external rotation injury is a lateral and/or medial malleolus fracture with deltoid ligament tear.[2,3,6,24] In this regard, it has been reported that the frequency of complete avulsion of the superficial components of the deltoid ligament of the proximal portion of the medial malleolus reaches 70%. Therefore, repairing the medial ligamentous complex at the same time as the lateral malleolar fracture has similar results to fixation of the lateral malleolus in cases of syndesmosis injury in terms of functionality and radiographic findings.[2,3,6,24]

Deltoid ligament repair in ankle fractures has better anatomic reduction results and a lower pain score.[7,14] Over the past two decades, the diagnosis of deltoid ligament ruptures has been made in cases in which supination-external rotation is ≥5mm on stress X-rays;[7,14] however, the frequency of false positives has been reported to be 53.6 %, 26.9 % and 7.7 % in patients with SEM of ≥4mm, ≥5mm and ≥ 6mm, respectively.[7,14] This demonstrates that the presence of deltoid ligament integrity with an MCS between 4mm and 6mm on X-rays is not a completely reliable criterion in this type of injury.[7,14]

In a study performed by Rosa *et al.*[10] in 81 patients in which the use of ultrasonography was compared with that of stress X-rays, it was reported that patients with an intact deltoid ligament had an MCS of 2.7±0.5mm, while those with a ruptured deltoid ligament had an MCS of 5.9±3.4mm.[10] Furthermore, in that study, ultrasonography was found to have a sensitivity of 100% and a specificity of 90%, so the authors conclude that

this diagnostic technique is an accurate tool to identify medial complex disruption dynamically.[10]

The use of imaging studies is important to determine the stability of ankle fractures and to select the appropriate treatment. However, the diagnosis of deltoid ligament rupture through routine X-rays can often fail to evaluate talar shift and, therefore, may result in inadequate treatment. Similarly, performing stress X-rays in acutely injured patients can be difficult, as the application of force to place the limb in the correct stress position generates pain and discomfort. In this regard, it should be noted that these options are not ideal for determining the treatment of patients with these injuries in the emergency department.[9,13]

Nuclear magnetic resonance allows direct visualization of the deltoid ligament; however, its cost limits its routine use.[16,25] The use of ultrasonography has different benefits in the evaluation of tendons and ligaments of the ankle in trauma patients, since it is a dynamic study that makes real-time analysis possible, avoids exposing the patient to radiation, has a low cost, is not too painful for the patient, and allows the evaluation of rupture, subluxation and/or dislocation in real time.[16,25]

Ultrasonography allows the accurate diagnosis of deltoid ligament ruptures with a sensitivity and specificity of 100% compared to simple X-rays, which have a sensitivity of 57.1% and a specificity of 60%. Consequently, this technique allows a direct non-invasive evaluation of the medial structures in patients with isolated fractures of the peroneal malleolus, helping to differentiate between stable and unstable fractures, and providing important information for the selection of the appropriate treatment.[17]

Some limitations to the use of ultrasonography to assess the presence of ligament ruptures in patients admitted to the emergency department should be considered, such as the lack of immediate availability of ultrasonography equipment at the time of care by the orthopedic surgeon. However, the many benefits of its use include the low cost of its implementation and the possibility of making an effective diagnosis, which allows defining the best treatment (surgical management with osteosynthesis and ligament repair when the patient requires it).

Conclusion

This case report demonstrates the importance of using diagnostic imaging techniques other than conventional ones, such as ultrasonography and magnetic resonance imaging, in the evaluation of patients with deltoid ligament ruptures. Since the ultrasonograph is a small and low-cost instrument, it can be used in emergency and surgical services, as its acquisition is plausible in any health institution, public or private. Accordingly, it is possible to standardize its routine use, which, on the one hand, will reduce the waiting time for a nuclear magnetic resonance, as well as the length of the patient's stay in emergency and hospital wards, and, on the other hand, will allow for an effective and rapid diagnosis. In this sense, it is essential for the orthopedist to be familiar with this technique to identify the anatomical structures to be operated on.

Informed consent

The patient signed an informed consent form authorizing the collection and disclosure of the information.

Conflicts of interest

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