Case Report

Conservative management of a specific subtype of Maisonneuve fractures: a report of two cases

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Background: Maisonneuve fractures are most commonly characterised by a specific pattern with a medial malleolar fracture or deltoid ligament rupture, a disruption of the ankle syndesmosis ligaments and a fracture of the proximal fibula.

Case Description: We hereby describe for the first time two cases of conservative therapy of Maisonneuve fracture with intact medial structures and with associated posterior malleolus fracture. Patients were assessed with ankle radiographs and magnetic resonance imaging (MRI). The distal fibula was anatomically positioned in its notch and the deltoid ligament and interosseous membrane (IOM) were intact. In addition, the posterior malleolus fracture was not associated with talar subluxation or articular impaction, and the mortise remained anatomically positioned on the initial radiographs. Based on clinical and imaging evaluations, the decision was made to follow conservative treatment. Follow-up showed stability criteria on standing radiographs, and their evolution was clinically uneventful with a good AOFAS score after 1 year.

Conclusions: The discussion emphasized the scarce description of conservative therapy of Maisonneuve fractures for which surgical treatment is considered to be the gold standard. The good results of these two cases are in favour with conservative therapy, avoiding adverse events and complications related to surgery, and showed that conservative therapy should be also considered as an effective therapeutic option in selected cases. We also emphasize that the results of our two cases are, moreover, in favor of an early weight-bearing protocol.

Keywords: Maisonneuve fracture; syndesmosis lesion; conservative treatment; deltoid ligament; case report

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Introduction

Maisonneuve fractures are characterised by a pattern of the following lesions: a medial malleolar fracture or deltoid ligament rupture, a disruption of the ankle syndesmosis ligaments and a fracture of the proximal fibula. It was originally described by the French surgeon Jules Germain François Maisonneuve in 1840 (1). Diagnosis is often overlooked and probably occurs more often than assumed; among ankle fractures, Maisonneuve fractures accounting for 0.7% to 10% in some studies (2-4). It is frequently a sport-related injury, occurring in a relatively young population (4-6).

The main injury mechanism proposed is an external rotation of a pronated and fixed foot (1). The sequence of the injury is described as follows: the talus performs an external rotation and creates a strain on the medial column of the mortise. The force is then transmitted anteriorly,

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with the talus acting as a wedge, resulting in rupture of the anterior tibiofibular and interosseous ligaments. Disruption of the interosseous membrane (IOM) usually progresses to the neck of the fibula with a concomitant spiral fracture. Lesions most frequently associated with Maisonneuve fractures are the interosseous and anterior inferior tibiofibular ligaments (AITFL), the posterior malleolus, the deltoid ligament and the medial malleolus (7). Posterior tibiofibular ligament (PTFL) may be intact, resulting in partial diastasis of the mortise (8). The ankle joint can be considered as 2 columns: medial and lateral. Some authors consider the ankle as a ring where the bone and ligament structures contribute to its stability. If the ring is ruptured on one place, which means that only one column is broken, the joint remains stable. But if it is ruptured on 2 places, it becomes unstable. Therefore, in theory, a Maisonneuve fracture is unstable, since both columns are affected (9).

Maisonneuve fractures are a part of syndesmotic lesions. Syndesmosis lesions reach a consensus in the literature for surgical treatment in case of diastasis of the distal tibiofibular joint or associated fracture around the ankle (10-12). It is admitted that a syndesmosis lesion may be associated with a significant instability of the joint, which could lead to osteoarthritis if not adequately stabilized (13).

For ankle fractures in general, it is recognized that restoring anatomical congruence to the ankle joint is important to improve function and decrease post-traumatic osteoarthritis. Surgical or conservative methods are employed to allow the joint to heal in this sense. According to two recent meta-analyses, there is, to date, insufficient evidence to say which modality is the best to treat an ankle fracture considered unstable (14,15).

However, in most studies about the management of a Maisonneuve fracture, surgical stabilization of the syndesmosis is the first choice regardless of syndesmotic stability (16).

Nevertheless, some authors recommend conservative treatment for certain type of Maisonneuve fractures in case of partial disruption of the syndesmosis, in the absence of diastasis, or in the absence of ligament or bone lesion of the medial malleolus (8,17). However, posterior syndesmotic injury in the form of tibial avulsion fracture of the posterior inferior tibiofibular ligament (PITFL) (considered equivalent to a posterior malleolus fracture) was not considered in these studies, nor was the role of the medial column. Outcomes of conservative treatment are rarely described in the literature. The last comparison study was published in 1998 and found better outcomes in the operative group (18). Charopoulos *et al.* (19) published a case report of conservative treatment of a Maisonneuve fracture with integrity of the deltoid ligament, and with a non-weight bearing protocol.

Literature does not establish well-defined criteria for the decision of conservative treatment for Maisonneuve fractures. The purpose of this study was to describe for the first time the outcomes of two patients with Maisonneuve fracture injuries associated with an avulsion fracture of the PITFL and an intact deltoid ligament, treated successfully by conservative therapy with an early weight bearing protocol. Information from this report should provide a useful reference for physicians who treat these injuries. We present the following two cases in accordance with the CARE reporting checklist (available at https://acr.amegroups.com/article/view/10.21037/acr-21-67/rc).

Case presentation

All procedures performed in this study were in accordance with the ethical standards of the institutional and/or national research committee(s) and with the Helsinki Declaration (as revised in 2013). Written informed consent was obtained from the two patients for publication of these two cases and accompanying images. A copy of the written consent is available for review by the editorial office of this journal.

The first patient was a 40-year-old man who presented to the emergency department after a skiing accident with external rotation trauma of the ankle. The second patient was a 50-year-old woman who twisted her ankle in a fall down to the stairs. Clinical examinations revealed ankle swelling and tenderness on palpation of the ankle and also proximal fibula.

For both patients, radiographs at day 1 demonstrated a Maisonneuve fracture with an associated fracture of the posterior malleolus without talar subluxation (*Figures 1*,*2*).

At one week post-injury, radiological evaluation was completed with out of plaster weight-bearing radiographs, which showed no fracture displacement or diastasis of the distal tibio-fibular joint. Although stress radiographs are recommended to establish an accurate diagnosis (3), for reasons related to patient pain and anxiety and the need for anesthesia, we did not obtain such exams. Instead, magnetic resonance imaging (MRI) was performed in an effort to more accurately assess the status of the soft tissues and showed no rupture of the deltoid ligament, an intact PITFL, and a fibula anatomically positioned in the tibial

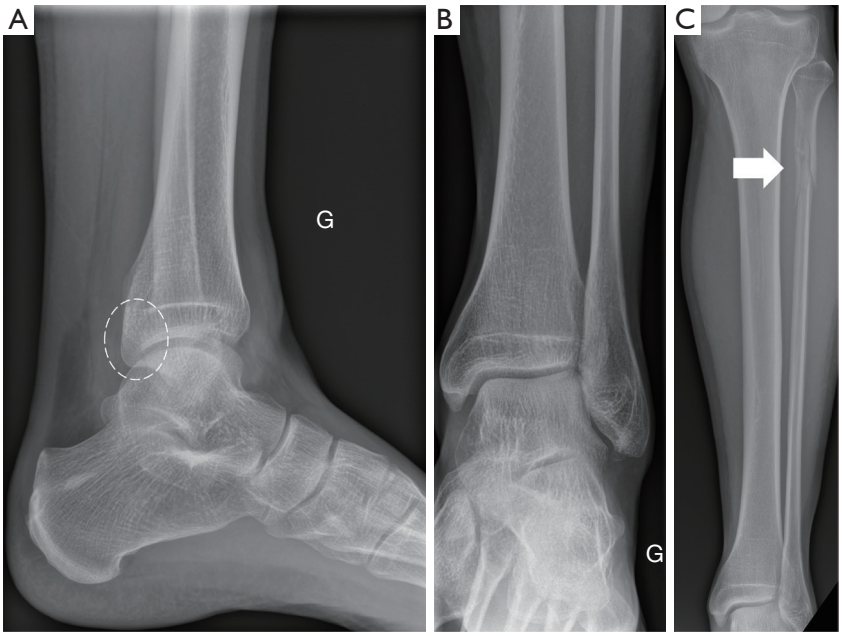

Figure 1 Left (G) ankle radiographs of case 1 at day 1. (A) Lateral left ankle radiograph showing the posterior malleolus fracture (white circle in dashed line). (B) AP left ankle radiograph showing a mortise in an anatomical position and the absence of tibio-fibular diastasis. (C) AP left leg radiograph showing a proximal fibula fracture (white arrow). AP, anterior-posterior.

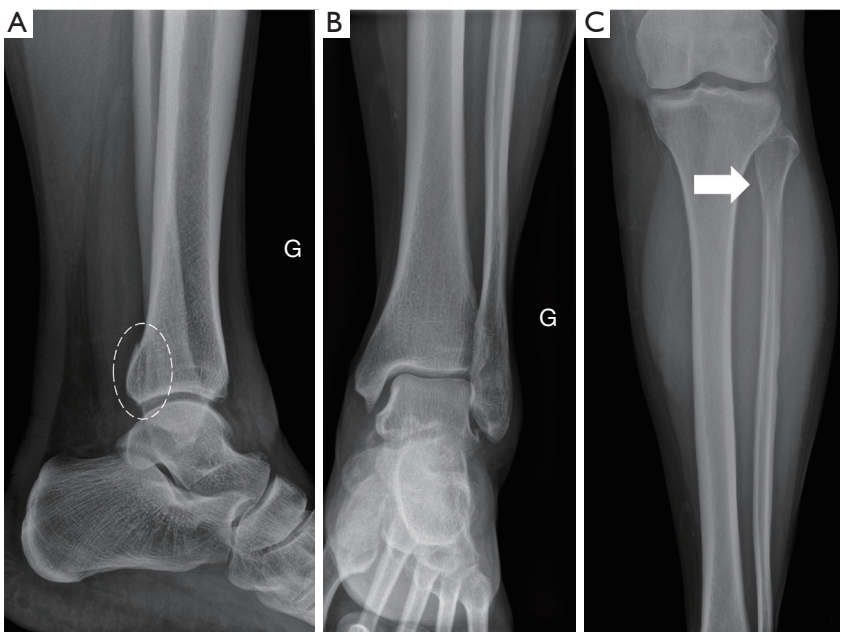

Figure 2 Left (G) ankle radiographs of case 2 at day 1. (A) Lateral left ankle radiograph showing a posterior malleolus fracture (white circle in dashed line). (B) AP left ankle radiograph showing a mortise in an anatomical position and the absence of tibio-fibular diastasis. (C) AP left leg radiograph showing a proximal fibula fracture (white arrow). AP, anterior-posterior.

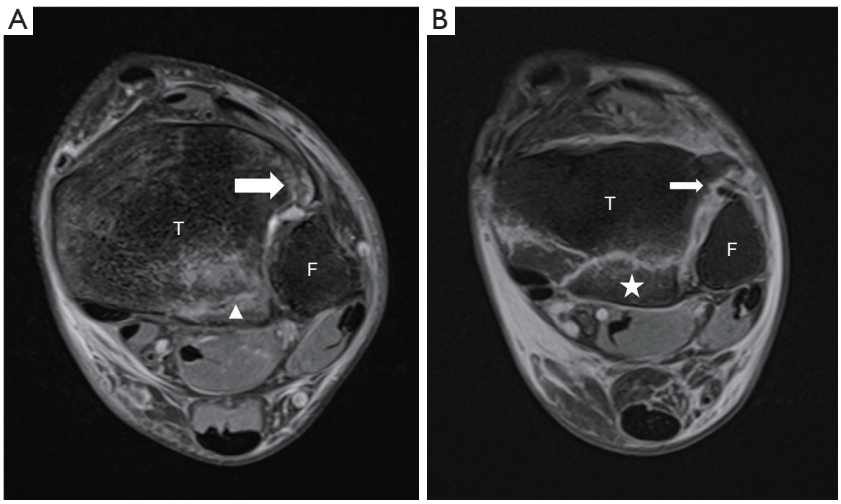

Figure 3 Left ankle proton density axial MRI of case 1 (A) and case 2 (B) obtained at 1 week. (A) Proton density axial MRI showing tibia (T), tibial bony avulsions of the AITFL (Chaput fragment: large white arrow) and PITFL (Volkmann fragment: white triangle). The fibula (F) is anatomically placed in the tibial notch. (B) Proton density axial MRI showing tibia (T), tibial bony avulsions of PITFL (Volkmann fragment: white star) and rupture of the AITFL (small white arrow). The fibula (F) is anatomically placed in the tibial notch. MRI, magnetic resonance imaging; AITFL, anterior inferior tibiofibular ligaments; PITFL, posterior inferior tibiofibular ligament.

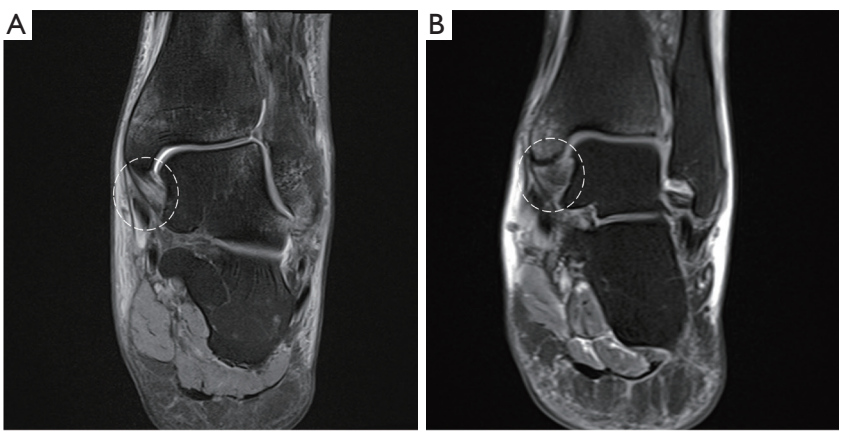

Figure 4 Left ankle proton density coronal MRI of case 1 (A) and case 2 (B) obtained at 1 week. Proton density coronal MRI showing an intact deltoid ligament in both cases (white circles in dashed line). MRI, magnetic resonance imaging.

notch (*Figure 3*,*4*). Complete MRI workup of the ankle ligaments can be found in *Table 1*.

Both patients were treated with a short leg walking cast for 6 weeks and were advised with partial weight-bearing aided by two crutches. After cast removal they were allowed to gradually begin full weight-bearing, under the supervision of the physiotherapist.

Standing radiographs at 6 and 12 weeks post-injury showed fracture healing and confirmed stability of the ankle (*Figure 5*).

Both patients were able to walk without limitation at 3 months after the injury. At 1 year, full range of motion of the ankle joint was achieved and the AOFAS scores were 90/100 and 82/100 for the first and second patients respectively. The second patient reported chronic ankle pain for several years related to hyperlaxity dating from

Table 1 Complete MRI workup of the ankle ligaments at 1 week for both patients

Anatomical structure	Case 1	Case 2
DL	Intact	Intact
AITFL	Tibial bony avulsion	Mid-substance rupture
PITFL	Tibial bony avulsion	Tibial bony avulsion
FCL	Rupture	Intact
IOM	Intact	Intact
Fibula in tibial notch	Centered	Centered

MRI, magnetic resonance imaging; DL, deltoid ligament; AITFL, anterior inferior tibiofibular ligament; PITFL, posterior inferior tibiofibular ligament; FCL, fibula-calcaneal ligament; IOM, interosseous membrane.

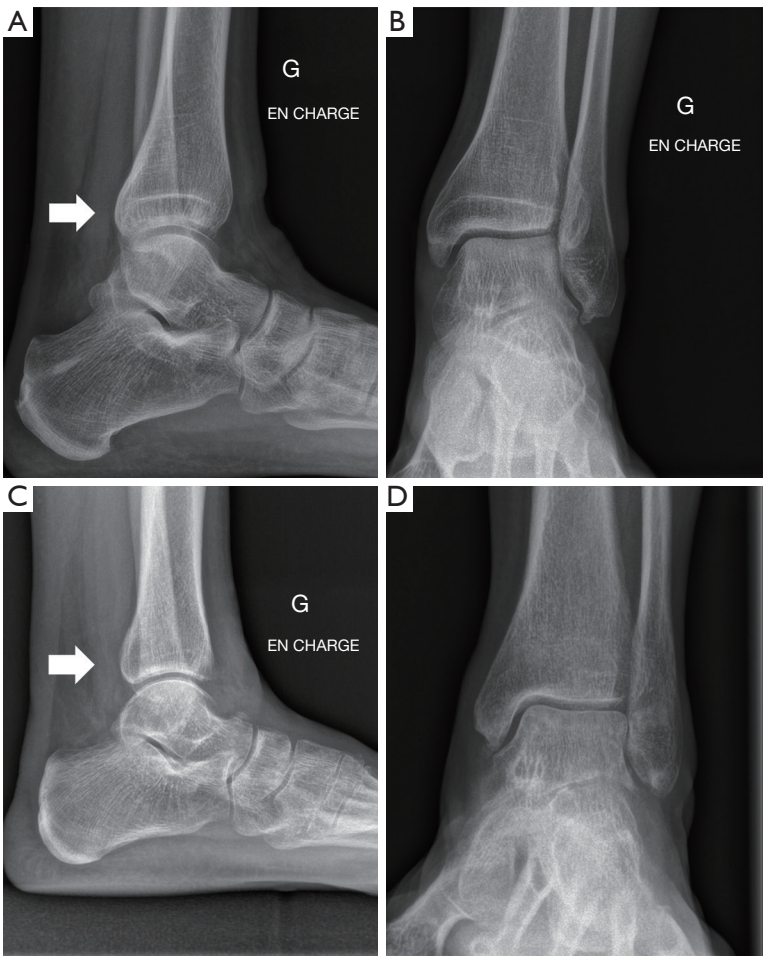

Figure 5 Left (G) ankle weight-bearing radiographs of case 1 (A,B) and case 2 (C,D) at 6 months. AP (B,D) and lateral (A,C) ankle weight-bearing radiographs of both patients showing bone union of the Volkmann fragment (white arrow) and a mortise in an anatomical position and the absence of tibio-fibular diastasis. AP, anterior-posterior.

before the accident.

Discussion

Clinical examination of the traumatic ankle includes an inspection of the skin followed by a palpation of deltoid ligament, lateral ligaments, syndesmosis and proximal fibula. If the proximal fibula shows tenderness, radiographs of the entire leg is mandatory (2). This allowed us to detect the two cases presented in this article. The workup was completed by weight-bearing radiographs, which attested to the stability of the syndesmosis throughout the follow-up.

Maisonneuve fractures don't have a specific classification. They are integrated into several commonly used classifications for ankle fractures. Pankovich developed a 5-stage classification based on the successive development of lesions leading to a Maisonneuve fracture (20). Fracture of the proximal fibula occurs in the fourth stage of the classification, while the rupture of the deltoid ligament or the fracture of the medial malleolus correspond to the fifth stage. In the Lauge-Hansen classification, Maisonneuve fracture is a subtype of pronation external rotation trauma (PER) of stage 3 (fracture of the fibula above the mortise) up to stage 4 (fracture of the posterior malleolus or PITFL injury) (21). In the current cases, the fractures may be classified as PER 4 according to Lauge-Hansen. In the PER subtypes, deltoid ligament rupture or medial malleolus fracture is present as early as stage 1. In contradiction to this classification, our two patients did not show either of these two lesions significantly. This contradiction shows that it cannot be based only on these classifications, because Maisonneuve fractures are apparently a continuum of different lesions, which cannot be integrated into one classification. Thus, to decide on a treatment, it appears important to make a thorough assessment of the lesions.

Based on the fracture stability of our patients on radiographs, we raised the possibility of conservative treatment. In this context, we chose to assess the ligament and cartilage lesions in details before deciding on such a treatment modality.

An important point to evaluate for conservative treatment is the competence of the medial structures. The medial column has been considered for the last 20 years, following various cadaveric studies, as the most important structure in the stability of the mortise.

A study by Michelsen tested the loading of cadaveric ankles by progressively simulating the different fracture stages of the SER classification according to Lauge-Hansen. It showed that the stability of a loaded ankle is mainly due to the deltoid ligament (22).

The absence of damage to the deltoid ligament and the medial malleolus, as in the Masionneuve fractures of our two patients, allowed to preserve the integrity of one column out of two of the ankle joint and thus to consider it as stable. This point, in line with Michelsen's study, made us feel comfortable with an early weight-bearing protocol, especially since the mortise remained in an anatomical position during weight-bearing radiographs. The fact that the IOM was not affected in our two patients also supported this choice of management.

As biomechanical studies have shown (23), the stability of the syndesmosis is mainly determined by the PITFL. In our 2 cases, the posterior syndesmosis was affected only in the form of bony tibial avulsion of the PITFL, equivalent to a posterior malleolar fracture. MRI demonstrated the absence of mid-substance ligament damage, talar subluxation or articular impaction, which would have required surgical stabilization (24). MRI also demonstrated the integrity of the IOM in our two patients. Although Maisonneuve's fracture is often associated with gross instability of the ankle, some authors have described it in association with a partial diastasis making the syndesmosis relatively stable because of the persistence of the IOM and the PITFL (8). Subsequent radiographs did not show any secondary displacement of the posterior malleolus, which would support our hypothesis, suggesting that a non-displaced PITFL bone avulsion has a better healing potential than a pure ligamentous injury of the PITFL. Thus, in association with an intact IOM, we can also, in our opinion, consider syndesmosis as relatively stable. In addition, the presence of the bone lesion has the advantage of allowing radiographic monitoring of PITFL healing in position, unlike a mid-substance PITFL lesion.

We have advocated that in addition to stability of the ankle, positioning of the fibula in the fibular notch is of paramount. Weening *et al.* (25) emphasized the importance of the correct position of the distal fibula, as this means that the distal tibio-fibular joint is anatomically reduced and this is a very important factor for a good functional outcome. Methods are described to evaluate the correct positioning of the fibula in its notch. We were able to confirm, using that of Bartoníček *et al.* and Futamura *et al.* (7,26) that the positioning in our cases was anatomical.

The results of fibular malpositioning, especially as a result of surgical treatment, have shown poor results (27). Thus, anatomical positioning of the fibula in its notch

is fundamental to consider a conservative treatment. Even with proper fibular position on mortise and lateral views, malposition of the fibula in its tibial notch may be possible, as shown in a study of 24 patients who underwent syndesmosis fixation with screws followed by postoperative CT monitoring of repositioning (26). We believe that a CT or an MRI are mandatory if conservative treatment is being considered, and not to rely solely on radiographs.

In the current cases, we observed that conservative treatment of Maisonneuve fractures with a non-displaced posterior malleolus lesion and integrity of the medial structures provides good clinical and radiological results, considering that the following criteria were obtained. In addition, we believe that a weight-bearing protocol can be introduced if these criteria are met and that it will lead to results comparable to a non-weight bearing protocol such as the one that Charopoulos *et al.* (19) introduced for his Maisonneuve fracture case with medial column integrity.

Criteria for conservative treatment of Maisonneuve fracture proposed in regard to this study:

- Initial radiographs with an anatomic position of the mortise without diastasis.
- Fracture of the posterior malleolus without talar subluxation or articular impaction.
- Persistence of anatomic mortise position on follow-up weight-bearing radiographs.
- Absence of secondary displacement of the posterior malleolus on weight-bearing radiographs at follow-up.
- CT-scan or MRI showing good position of the distal fibula in its tibial notch.
- Absence of deltoid ligament rupture on MRI.

Conclusions

We report two cases of Maisonneuve fracture with posterior malleolus fracture and integrity of the medial structures. Following a detailed analysis of anatomic injury characteristics, we suggest that these lesions are at low secondary displacement risk provided they meet the criteria presented in this article. Based on the experience of these patients, in contrast to other subtypes of Maisonneuve fractures, we recommend conservative treatment for these lesions.

Further studies comparing operative and conservative treatments should be performed to validate the above criteria. In the future, if some Maisonneuve fractures could be treated conservatively, this may reduce the number of surgical treatments, their complications, and also reduce the length of hospital stay and potential costs.

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Footnote

Reporting Checklist: The authors have completed the CARE reporting checklist. Available at https://acr.amegroups.com/article/view/10.21037/acr-21-67/rc

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Conflicts of Interest: All authors have completed the ICMJE uniform disclosure form (available at https://acr.amegroups.com/article/view/10.21037/acr-21-67/coif). The authors have no conflicts of interest to declare.

Ethical Statement: The authors are accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved. All procedures performed in this study were in accordance with the ethical standards of the institutional and/or national research committee(s) and with the Helsinki Declaration (as revised in 2013). Written informed consent was obtained from the two patients for publication of these two cases and accompanying images. A copy of the written consent is available for review by the editorial office of this journal.

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