The posterior malleolar fracture: A parachute injury not to be overlooked

G. Comat a, O. Barbier b,*, D. Ollat b

a Hôpital d'instruction des armées R.-Picqué Bordeaux, 351, route de Toulouse, 33800 Villenave-d'Ornon, France
b Hôpital d'instruction des armées Bégin-Saint-Mandé, 69, avenue de Paris, 94160 Saint-Mandé, France

1. Introduction

Isolated posterior malleolar tibial fracture is rare and often overlooked. The first and only description is Tobin's, of 1943 [1], identifying this form, which he named “paratrooper fracture”. Literature data for trauma in parachuting are presently sparse [2] and descriptions of marginal posterior malleolar fracture as such are few [3–6].

The principal hypothesis of the present study was that this form of fracture is under-diagnosed, due to lack of awareness and difficulty of diagnosis. The second hypothesis was that delayed diagnosis impairs functional prognosis.

The study analyzed a retrospective series of 12 cases occurring between 2006 and 2011 in two paratrooper regiments, to identify clinical and paraclinical factors able to improve diagnosis and treatment outcome.

2. Material and method

A retrospective study included all members of two French paratrooper regiments presenting with isolated posterior malleolar tibial fracture sustained during a parachute jump between May 2006 and February 2011.

Exclusion criteria were: fracture sustained in other contexts, such as high falls or sports accidents with equinus torsion/varus of the ankle, or Cunéo-Picot (trimalleolar) fracture [7]: i.e. the study focused exclusively on parachute-jump trauma.

Data were collected retrospectively from medical files and a questionnaire. Patients were interviewed either by telephone or in consultation.

The questionnaire concerned:

- patient data: gender, age, body-mass index (BMI), occupation and professional experience in parachuting;
- jump-related data: day versus night jump, jumping with heavy loads (weapons, bag), wind-force, type of landing area;
- compliance with jump and landing instructions: feet tight together, “roll” technique.


* Corresponding author. Tel.: +33 143985020.
E-mail addresses: olive.barbier@gmail.com, olive.barbier@me.com (O. Barbier).

http://dx.doi.org/10.1016/j.otsr.2014.02.008
1877-0568/© 2014 Elsevier Masson SAS. All rights reserved.
Initial clinical examination data were analyzed for items corresponding to the Ottawa Ankle Rules [8]: pain foci, haematoma, and functional impotence. Treatment history was recorded with imaging results: AP and lateral ankle radiographs and/or CT.

Treatment results were analyzed in terms of residual pain and duration of functional incapacity.

3. Results

Twelve patients were included for a total 65,000 jumps during the study period: i.e., an incidence of 0.0002% isolated marginal posterior malleolar tibial fracture per jump. All patients were male; mean age at trauma was 30.6 years (range, 20–40 years). Mean BMI was 23.7 kg/m² (range, 20.5–26.2 kg/m²). Experience varied: 7 were categorized as highly experienced (>50 jumps), 4 as experienced (20–50 jumps) and 1 as a novice (i.e., <5 jumps). The accident occurred during a daytime jump in 6 cases, including 2 with load (weapon and 20 kg survival kit) and 1 in which the parachute opened late; the other 6 cases were night jumps, including 4 with load. Three cases involved rear wind at landing. Landing terrain varied: 6 subjects landed in a hole, and 2 on unstable ground. Landing was normal in only 1 case; the others involved 1 or more incidents: 4 landed without keeping their feet tight together, 3 hit the ground with their toes, and 2 failed to execute the “roll”.

At the accident, 8 patients experienced immediate intense pain with total functional impotence. The other 4 reported moderate pain without immediate functional impotence. Six experienced a “cracking” sensation.

Initial primary-care clinical examination found haematoma in 4 cases, systematically associated with total functional impotence. In the other 8 cases, weight-bearing was possible but painful. Two patients experienced diffuse pain on palpation of the bone relief and ligaments; 4 had medial retromalleolar pain and 1 had lateral malleolar pain. Clinical examination was poorly contributive in 5 cases, finding diffuse oedema and no osseous or ligamentous pain foci.

All patients underwent AP and lateral ankle X-ray during the initial consultation. The Ottawa rules were met in only 9 cases of total functional impotence (inability to take more than 4 steps) immediately post-trauma or on examination and/or pain on palpation of the malleoli and 5th metatarsal base; the other 3 did not initially correspond to the Ottawa criteria: i.e., following the Ottawa Ankle Rules, 25% of the fractures would initially be overlooked. Initial radiology diagnosed isolated posterior malleolar fracture in 3 cases. Initial clinical and radiological diagnosis was “benign” pain in 3 cases, “serious” pain in 6, and isolated posterior malleolar fracture in only 3 cases.

For the 3 patients with initial diagnosis of marginal posterior malleolar fracture and the 1 case with “serious” pain, primary management consisted in 6 weeks’ posterior plaster cast immobilization. The other 8 patients received functional treatment (rest, ice packs and analgesics) followed by rehabilitation or return to personal and sports activity.

Seven of the 9 patients without initial diagnosis of fracture returned in consultation with persistent retromalleolar pain and 2 with persistent ankle oedema. In 1 case, reinterpretation of initial radiographs corrected the diagnosis; the other 8 underwent complementary imaging (MRI in 3 cases, and CT or arthro-CT in 5) within 1 week to 3 months, resulting in correct diagnosis.

Retrospective reinterpretation of these 8 patients’ initial radiographs identified the overlooked marginal posterior tibial malleolar fracture. For the 9 patients without initial diagnosis of fracture, mean time to diagnosis was 41 days (range, 7–90 days). None of the fractures were displaced, and joint ratios were conserved. Lateral ligament lesions were found on 2 arthro-CT-scans. On CT or MRI, fracture lines were intra-articular in 8 cases, involving less than one-third of the joint surface, and all fractures were isolated. Functional treatment was continued in the 7 cases in which diagnosis was more than 6 weeks post-accident; in the 2 cases diagnosed before 6 weeks, plaster cast immobilization was prescribed for a period of 6 weeks post-trauma.

Table 1 compares results between early and late diagnosis.

Mean follow-up was 28.8 months (range, 6–60 months). Late diagnosis was associated with longer incapacity and more severe physical sequelae: cracking, pain and stiffness. No patients with early diagnosis and treatment showed sequelae.

4. Discussion

The present study confirmed the difficulty of diagnosing isolated posterior malleolar tibial fracture in parachutists.

Firstly, initial clinical examination found few symptoms in more than half the cases, and was poorly specific. This finding is in agreement with those of Boggs [4] in 1986 and Nugent and Gale [5] in 1990, who found a clinical presentation of partial functional impotence, yet emphasized what they took to be a fairly specific functional sign: medial retromalleolar pain, which was found in only 4 cases in the present series.

Secondly, on radiography, 25% of the present fractures did not meet the Ottawa Ankle Rules [8,9] and would therefore have been initially overlooked on that basis. Many authors have pointed the lack of sensitivity and specificity of these rules. In 2002, Glas et al. [10] insisted that the clinician’s experience is of greater value than the Ottawa Rules, and in 2003 Bachmann et al. [11] found the rules too subjective, especially in the acute phase. Kelly et al. [12] and Warren and Knottenbelt [13] recommended counting all high-energy trauma (high falls, trauma in hyperextension) as exceptions to the rules.

Thirdly, radiologic results showed poor diagnostic sensitivity in the present series: all underwent initial imaging, with plain X-ray and standard views (AP and lateral), but only 25% of fractures were diagnosed as such initially (Fig. 1A and B). In the other cases, diagnosis was corrected either on re-reading the initial images or on complementary imaging. As early as 1971, Mandell [3] observed that superimposition between tibia and fibula could mask such fractures; for detection, he advised a lateral view with the foot in slight external rotation, so as to identify the fibula behind the posterior margin of the tibia. Ebraheim et al. [14], on the same grounds, suggested 50° external rotation. This view of the ankle in external rotation thus seems necessary in case of clinical suspicion (medial retromalleolar pain) or context suggestive of plantar hyperflexion (fall onto the toes, into a hole, on relief liable to induce hyperextension) as a complement to the standard imaging used in routine
ankle traumatology. In case of doubt, we consider CT justifiable for positive diagnosis, to assess fracture length and displacement precisely. In the present series, the posterior marginal fragment was never displaced or greater than one third of the joint surface, but several authors [15–17] have pointed out that, in these fractures, the fragment is often underestimated on standard lateral X-ray due to the obliquity of the fracture line, making systematic CT justifiable [18].

Thus, despite its retrospective design and small sample, the present study demonstrated the lack of sensitivity of clinical

---

**Fig. 1.** Metaphyseal-epiphyseal joint fracture of the postero-inferior third of the tibia. A. plain X-ray. B. CT.

---

**Fig. 2.** Decision tree in suspected isolated posterior malleolar tibial fracture (RICE: Rest, Ice, Compression and Elevation).
and radiological assessment for positive diagnosis in these cases. Physicians managing such patients need to be aware of these pitfalls, however rare this form of fracture. Indeed, incidence in the present series was 0.0002%; Nugent and Gale [5] reported about 1%, whereas Tobin [1] in 1943, had found an incidence of 12% in parachutists at that time. These differences may be attributed to the evolution of jump techniques and the preparation of personnel and equipment. The study population consisted of young athletic subjects, rigorously selected before assignment to airborne divisions. Landing techniques have developed: they used to consist in a forward roll, with no instruction to keep the feet tight together, with a risk of plantar hyperflexion and posterior malleolar fracture. In the present series, poor landing positions involving plantar hyperflexion were implicated in most cases, impacting the talus on the posterior margin of the tibia, with resultant fracture. This trauma mechanism was well described by Tobin [1], Nugent and Gale [5] and Boggs [4], resulting from a principal force of axial compression exerted on the posterior fragment by the talus under plantar flexion (grade C on Kleger’s classification [19]). Fracture may be associated with anterior and posterior tibiopenoral ligament tear. Landing techniques have been refined, and now comprise a lateralized roll, feet tight together (Fig. 2). Bricknell and Craig [20] in a meta-analysis seeking to determine precise rates for the various traumatic lesions found in military parachuting between 1940 and 1999, confirmed that changes in landing techniques had considerably reduced the rate of traumatic lesion associated with this critical phase. Isolated posterior malleolar talib fracture thus seems mainly to occur in parachutists, due to the specificities of this activity.

Finally, we may raise the question of the impact of delayed diagnosis on management and outcome. In the present series, delay seemed to impair functional results and worsen sequelae. None of the 4 cases of initial cast immobilization showed long-term sequelae, whereas 75% of delayed diagnoses were associated with sequelae such as pain, cracking sensations, stiffness or vasomotor disorder. In terms of treatment, in the present series, posterior malleolar fragments were non-displaced and did not exceed one third of the joint surface, allowing functional treatment, demonstrating the importance of early diagnosis if immobilization is to be initiated straight after trauma. Posterior malleolar fragments seem to significantly increase osteoarthritic complications in case of involvement of the inferior tibiofibular ligaments, even when fragments are small [6,18,21]. This form of fracture is thus very liable to induce osteoarthritis, especially when diagnosis and treatment are delayed, as it is a joint fracture with a poorly vascularized bone fragment (there being no muscle insertions to the posteroinferior side of the tibia). Moreover, the talib plafond has to bear the entire body weight on an area of only 4 cm², inducing considerable stress [22–24]. Any reduction in joint surface area is thus liable to lead to osteoarthritis, due to increased stress per unit area. Functional treatment is recommended in non-displaced fracture [21] involving a low risk of tibiotalar osteoarthritis; displacements exceeding 25% of the joint surface, on the other hand, should be managed by open surgery, which considerably reduces the rate of post-traumatic osteoarthritis [22].

5. Conclusion

Isolated marginal posterior malleolar talib fracture is fairly specific to parachuting; physicians need to be aware of it and know how and when to suspect it, as functional signs are misleading and physical signs poorly specific. Early screening in parachute troops should explore for risk-enhancing circumstances: night jump, with load, irregular ground, rear wind. Clinical examination should look for medial retromalleolar pain. The Ottawa Ankle Rules should not be applied in case of suspect factors. Radiography should include a view in external rotation. In case of non-diagnosed persistent pain at 7-day reassessment, early CT examination is recommended (Fig. 3). The delay in diagnosis impairs the functional prognosis. Outside the context of parachute jumps, these elements may also be useful in everyday traumatology in case of falls from a very great height.

Disclosure of interest

The authors declare that they have no conflicts of interest concerning this article.

References
