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CASE REPORT

Sonographic diagnosis of radiographically undetectable bennet fracture

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Abstract
Intra-articular fractures of the base of the first metacarpal (Bennet fractures) are prone to dislocation and require surgical reduction and fixation to prevent secondary degenerative joint disease and chronic dysfunction. Therefore, a prompt diagnosis is necessary, mostly achieved by conventional roentgenograms. We report the case of a 62-year-old man in whom a Bennet fracture was highly suspected on ultrasound (US) examination realized after a fall. Standard radiographs, obtained after US to confirm the diagnosis, were interpreted as normal. A computed tomography was then performed showing a typical Bennet fracture. This case report demonstrates that a careful assessment of bones must be an integral part of any routine musculo-skeletal US examination, particularly in post-traumatic patients. US can detect bone fractures where radiograph is not discriminating.

Keywords Bennet fractures · Musculo-skeletal ultrasound · Joints · Trauma

Introduction

First metacarpal bone fractures are quite common, accounting for 4% of all adult hand fractures [1]. Intra-articular fractures are often unstable owing to associated lesions of the ligaments stabilizing the first carpo-metacarpal joint (1st CMCJ) as well as the deforming action of local muscles (Figs. 1 and 2). Unstable fractures require surgical management, in contrast to extra-articular fractures, which are mainly treated conservatively [2].

Intra-articular fractures of the base of the first metacarpal, “passing obliquely across the base of the bone and detaching the greater part of the articular surface”, with a single beak fragment [3] and additional further comminuted variants with multiple fragments are known as Bennet fractures (BF). They represent around 30% of first metacarpal fractures [4].

The first-line diagnostic method to confirm a clinically suspected BF is a standard radiography. Nevertheless, up to 70% of all carpometacarpal fractures are underdiagnosed because of superposition of adjacent bones or incorrect radiographic projections.

We present the case of a post-traumatic patient where ultrasound (US) strongly suggested a BF, not confirmed by radiographs but subsequently proved by a computed tomography (CT).

Case report

A 62-year-old man was referred for US evaluation of his left thumb due to acute pain following a bicycle fall. Physical examination revealed local pain and tenderness over the thenar eminence with palpable skin tension. The overlying skin was continuous with subcutaneous swelling, there was no evidence of hematoma. Neurological and vascular examination were normal. Range of motion of the thumb was painful and limited.

US was obtained to rule out soft tissue trauma. The examination was performed by transverse and longitudinal conventional images on the 1st CMCJ and thenar eminence followed by color Doppler assessment. A commercially available equipment (Affinity 50, Philips Healthcare, Best,

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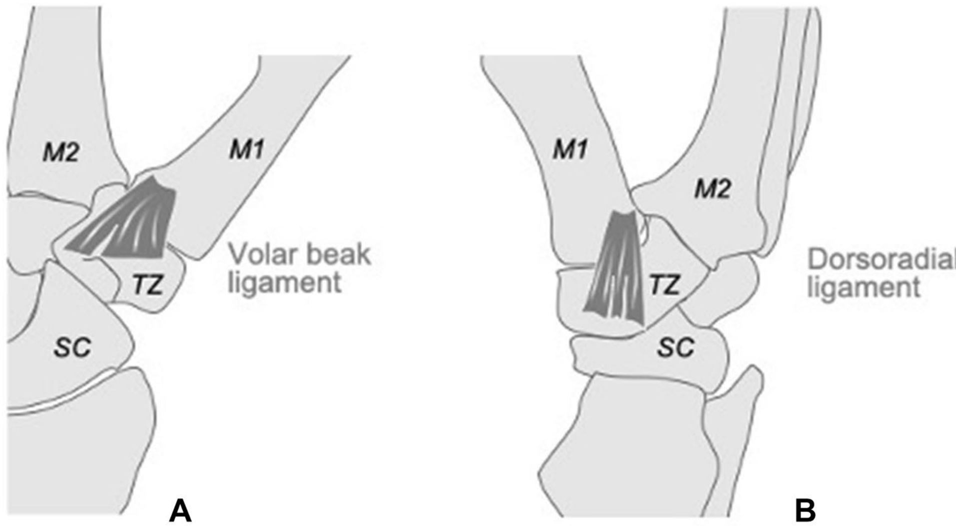

Fig. 1 Anatomical drawing showing the volar beak ligament (**A**) and the dorsoradial ligament (**B**), the main stabilizing ligaments of the first carpo-metacarpal joint. *M1* first metacarpal, *M2* second metacarpal, *TZ* trapezium, *SC* scaphoid

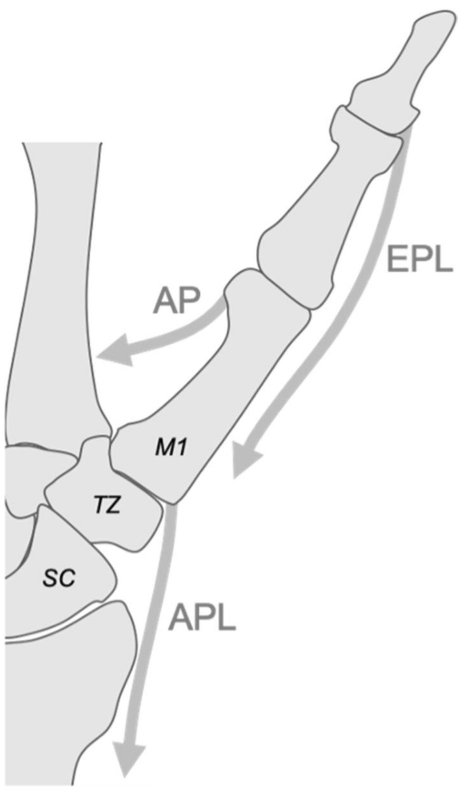

Fig. 2 Main forces displacing the first metacarpo-phalangeal joint. *AP* adductor pollicis, *APL* abductor pollicis longus, *EPL* extensor pollicis longus, *M1* first metacarpal, *TZ* trapezium, *SC* scaphoid

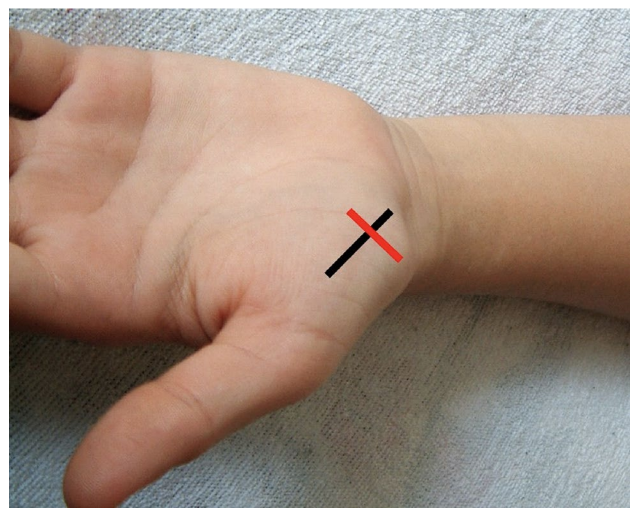

Fig. 3 Black line: transducer position for longitudinal scans corresponding to **A, B** in Fig. 4. Red line: transducer position for transverse scans corresponding to **C** in Fig. 4

Netherlands) equipped with a linear electronic multi-frequency transducer (L 18-5 broadband array) was used by a 40- years experimented musculoskeletal radiologist.

US images over the palmar aspect of the 1st CMCJ on the most tender area (Fig. 3), showed a focal interruption of the first metacarpal base hyperechoic cortical line with the presence of a local bone fragment, a joint effusion and a hypervascularized synovial hypertrophy (Fig. 4). No ligaments/tendons/muscles and nerves lesions were observed.

Based on the US and clinical appearance a BF was diagnosed and a X-ray was requested for further confirmation. Antero-posterior and lateral radiographs of the 1st CMCJ, carried out three days later, were interpreted as negative for fracture (Fig. 5). The discrepancy between US and radiographs, warranted a CT verification that was exhaustive for a classical BF, identifying two intra-articular comminuted bone fragments (Fig. 6).

The fracture was treated by open reduction and internal fixation (ORIF), (Fig. 7) with a good clinical outcome.

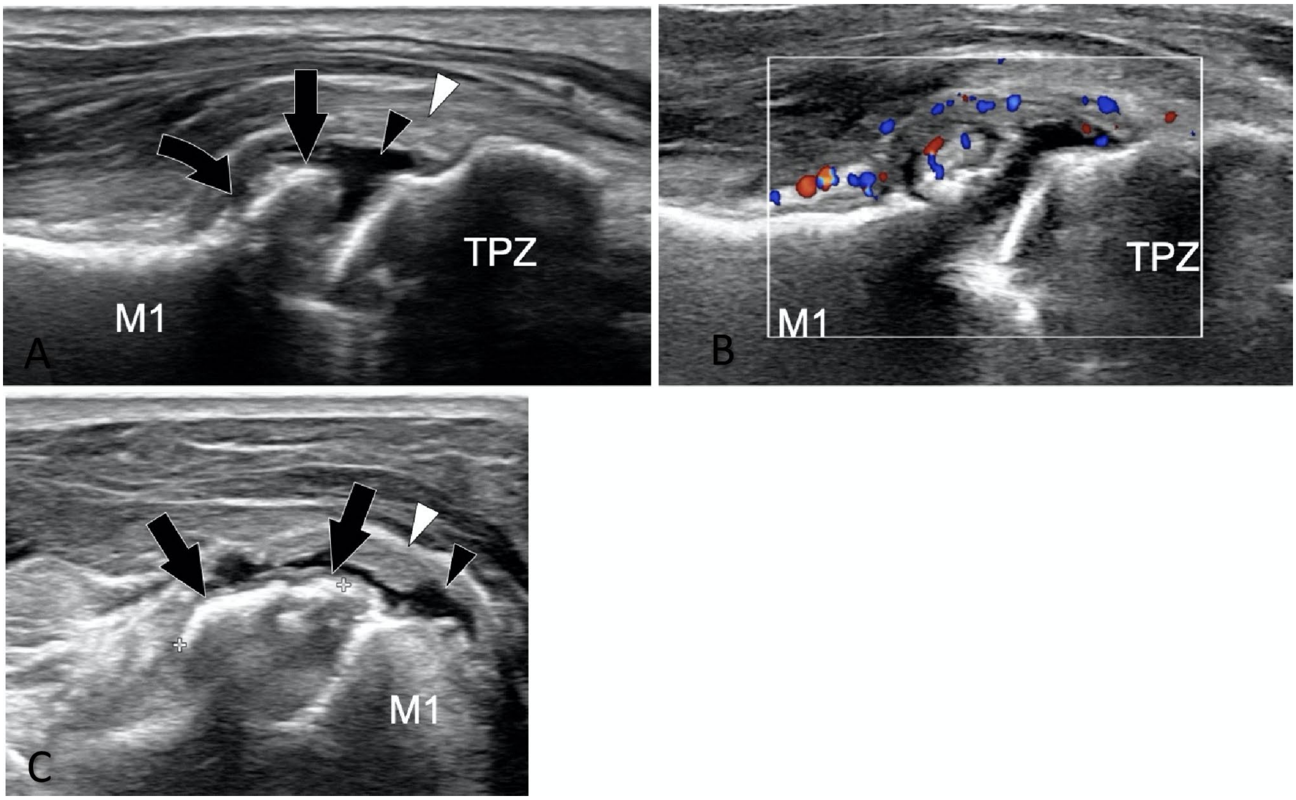

Fig. 4 Longitudinal (**A**, **B**) axial (**C**) US images obtained as shown in Fig. 3. **A**, **B**. The focal interruption (curved arrow) of the palmar aspect of the base of first metacarpal (M1) highly suggests a trapezio-metacarpal intraarticular fracture associated with a joint effusion (black arrowhead) and a synovial hypertrophy (white arrowhead). Arrows, calipers = triangular bone fragment located at the base of M1. *TPZ* trapezium. **B** Color Doppler shows hyper-vascular changes on the inflamed synovium

Fig. 5 Lateral (**A**) and antero-posterior (**B**) radiograph obtained after US examination, interpreted as negative for bone fracture

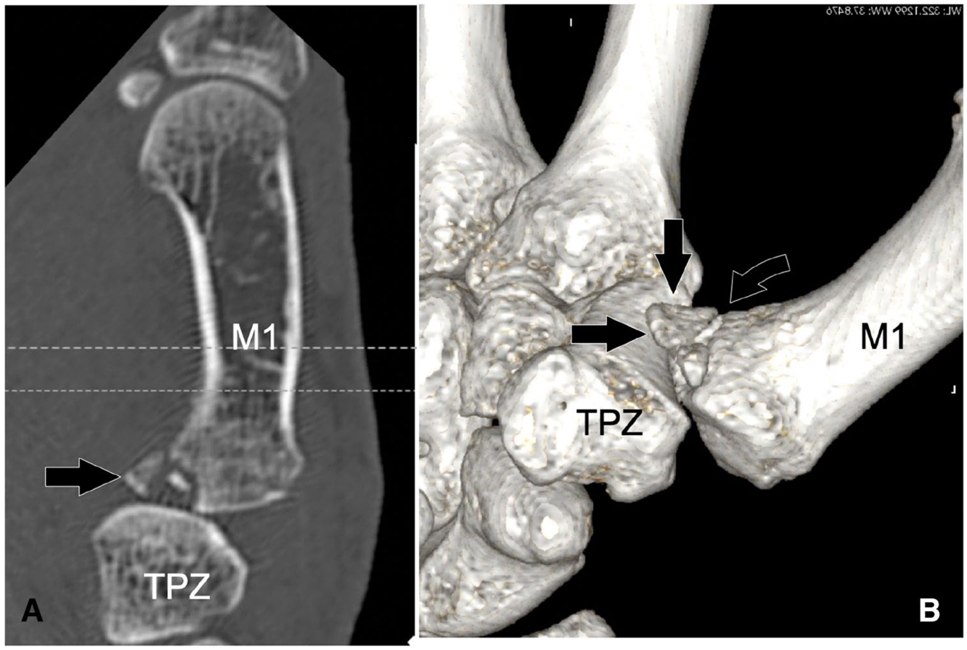

Fig. 6 Sagittal reformatted (**A**) and 3-D (**B**) CT reconstruction images obtained after radiographs. Images show the Bennet fracture (curved arrow) of the palmar aspect of the base of first metacarpal (M1). Arrows = triangular bone fragments located at the base of M1. *TPZ* trapezium

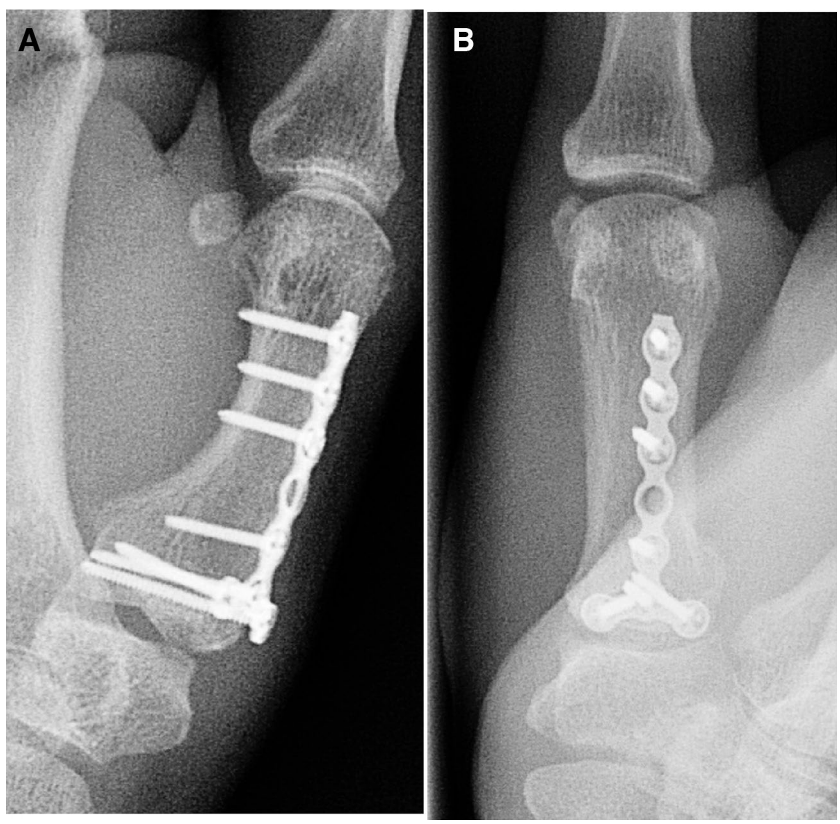

Fig. 7 Lateral (**A**) and antero-posterior (**B**) radiograph following Bennet fracture open reduction and internal fixation (ORIF)

Discussion

Fractures of the first metacarpal bone are essentially observed in athletes and in young males.

A clear comprehension of 1st CMCJ anatomy and function is necessary to explain the consequences of traumatic injuries. Physiologically 1st CMCJ stability is sacrificed to allow large thumb movements, determinants for hand prehension and above all for opposition. Sixteen ligaments are involved to supplement 1st CMCJ stability [5–7], but the principal stabilizers are the anterior oblique ligament (AOL) and mostly the dorsal radial ligament (DRL). The DRL originates from the trapezium tubercle and inserts at the base of the first metacarpal on its radial side, sometimes adjacent to the insertion of the abductor pollicis longus (APL) tendon. It serves as a pivot point in 1st CMCJ stability during power pinch and power grasp and in the terminal phase of opposition known as the "screw home torque" mechanism [8].

In BF, the mechanism of injury is an axial load over a flexed thumb causing a metacarpal base fracture. A secondary DRL complete or partial tear produces joint instability and dislocation even if the AOL is continuous [8]. The tendons of the muscles inserting on metacarpal and proximal/distal phalanx i.e., the adductor pollicis (AP), the abductor pollicis longus (APL) and the extensor pollicis longus (EPL) act as a deforming forces that displaces the fragments after the injury [8]. Usually, the metacarpal bone tends to dislocate radially and dorsally, while the smaller fragment connected to the trapezium by the AOL, remains in his place.

The most frequent BF does not include a complete DRL rupture: in this case a close reduction is possible only in fresh BF (less than 5 days); after 5 days soft tissue healing may interfere with a close reduction, so an open approach is preferred. On the contrary, BF with a complete DRL break,often requires an open surgical reduction [8].

Early detection of BF is essential since if left untreated it can lead to osteoarthritis causing pain, deformity, grip and pinch strength reduction and thumb multiplanar movements limitation [2].

Symptoms and clinical signs of BF are not specific, and a definitive diagnosis is mostly obtained by a well-performed standard radiograph, occasionally with additional projections.

Until recently, due to its intrinsic properties, US was usually adopted in musculoskeletal trauma to assess soft tissue injuries only if a fracture was not considered. Although US does not represent the first imaging modality for bone, many works have extensively described the excellent US performances in bone trauma [9–13]. Several studies have found no difference in accuracy between US compared with conventional radiography in the detection of some bone fractures [9]. On the contrary in an emergency setting, other authors have shown different results: bedside ultrasound respectively is [10] and is not [14] a reliable method for diagnosing fractures of the upper and lower limb extremities compared with radiography. These conflicting results may be linked to the age of the patients and the different anatomical regions evaluated.

Beltrame et al. [15] in a study of 86 patients, comparing US versus radiography after a trauma, concluded that US bone assessment is comparable to radiography only when joints are not involved in the injury. In this case, one US limitation, might be the inability to scan the entire bone contour due to patient pain, limiting joint excursion.

Hand fractures can seldom be difficult to identify for their complex anatomy and US use is to some extent controversial [16–18]. However, several articles described a reliable US employ for scaphoid, hamate, and sesamoid fractures [12, 19] as well as metacarpal bones lesions (20). A suitable sonographer training is mandatory to recognize those complicated patterns and may explain the above-mentioned contrasting conclusions. In addition, specific sonograms targeted to evaluation of bones, must be required after “standard US scans” to rule out fractures.

To the best of our knowledge this is the first report of BF diagnosed by US examination. PubMed research using the key words “Bennet fracture”, “Ultrasound”, “Diagnosis”, “Trauma” was made, and we found no other US descriptions of BF.

An early diagnosis conditions the BF surgical treatment: in our description, the delay in diagnosis constrained the orthopedic surgeon to perform an open surgery even though, as we comment above, the articular ligaments, in particular the DRL was intact.

This case report highlights the importance of performing a complete US examination in musculoskeletal trauma, including bone cortex, to find fractures with a poor outcome if left untreated, as in our case. Given the interaction between patient and examiner, US allows a more focalized assessment based on signs and symptoms reported, also adopting additional nonstandard scanning planes.

Conclusions

US is nowadays frequently requested in extremity trauma when a fracture is not suspected. It is important to stress that sonologists must always evaluate cortical bone in every examination.

Conventional radiography still represents the gold standard technique for post-traumatic hand bone fractures. US will not replace radiograph, but it accounts for a complementary method to triage patients for X-ray or as a negative predictive confirmation exam.

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Declarations

Conflict of interest The authors have no conflicts of interest to disclose.

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Consent to participate Not applicable.

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