



Hand compartment syndrome and literature review

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Summary: - Crush injuries to the hand are associated with a poor prognosis. The development of compartment syndrome in this context is feared but rare and preferentially affects the radial interosseous muscle compartments due to anatomical particularities. The usual clinical signs associate an edematous hand, in a discreet intrinsic position, with significant pain, resistant to pallier III analgesics. Passive extension of the digital joints increases this pain.

The diagnosis evoked clinically is made by taking the muscular pressures of all compartments so as not to overlook a case. The whole point of this development lies in the difference in pressure between the muscle compartments which, if ignored, can be the cause of a surgical error.

Dermo-fasciotomy is the only treatment to relieve muscle ischemia and stop the irreversible vicious circle. The functional prognosis of the hand is compromised by compartment syndrome. This dermo-fasciotomy must not suffer any delay.

Keywords: Compartment syndrome; Metacarpal fractures; Hand, aponeurotomy.

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Introduction:

The occurrence of compartment syndrome is a concerning yet well-recognized complication. However, its manifestation in the hand is less common, even when associated with trauma such as crushing injuries, burns, or injection of various substances. The outlook is poor in cases where diagnosis is delayed, often resulting in the loss of hand functionality. The challenge in diagnosing this condition arises from a specific anatomical feature that leads to significant pressure differences between compartments, which can result in misunderstanding if pressure is only measured in the compartments on the ulnar side. In this report, we present a clinical case of compartment syndrome in the hand resulting from crush trauma accompanied by multiple metacarpal fractures.

The case presentation:

This is a 31-year-old right-handed laborer who presented with trauma to his right hand following a public road accident, specifically a motorcyclist being struck by a car. This incident resulted in severe pain and complete loss of function in the affected hand. The diagnosis of compartment syndrome, as described by Spinner et al. [1], was established based on a triad of symptoms: spontaneous pain, paralysis, and exacerbation of pain during passive extension or stretching [2,3]. The patient experienced intolerable pain that remained unresponsive to level III analgesics, which is a concerning indication [2-4]. Palpation of the muscle groups revealed increased volume, which intensified the pain; however, this pain must be considered in the context of any associated fractures [4]. Upon examination, the patient exhibited an edematous hand positioned in a slight intrinsic posture, along with

a loss of skin elasticity (Fig1). These findings are characteristic of compartment syndrome [1,5-7].

The clinical presentation may include neurological signs, particularly concerning when they involve motor functions; however, in this instance, a paresthesia localized to the median nerve area was observed. The radiological evaluation (Fig2) indicated multiple fractures of the metacarpals in the right hand (M2-M3-M4-M5), without any associated dislocation or presence of foreign bodies.

Given the emergence of these symptoms, compartment syndrome should be promptly considered, necessitating urgent surgical intervention to prevent further deterioration of the clinical situation, which could lead, if untreated, to complete and permanent loss of hand function due to retraction of the intrinsic muscles, a condition known as Finochietto syndrome [8,9].

The patient underwent an urgent operation under general anesthesia and was positioned supine with the hand placed on a hand table, monitored under fluoroscopic guidance. Metacarpal fractures were stabilized through closed intramedullary pinning after achieving reduction via external maneuvers (Fig 3). Two pins were inserted for the fixed metacarpals M2 and M3 to provide adequate stability, as these metacarpals are particularly sensitive to rotational disturbances. Compartment syndrome was addressed by performing a dermo-fasciotomy (aponeurotomy), which is the only effective method to alleviate pressure within the compartment [3,4]. Following the approach by Masquelet [3], two dorsal incisions were made (on the radial edge of M2 and on M4), along with one incision in front of the carpal tunnel to section the anterior

annular carpal ligament, thus preventing injury to the median nerve while evacuating the hematoma (Fig 4). A final clinical and radiological check was performed at the six-month mark (Fig. 6)

Discussion:

Hand compartment syndrome is uncommon, though it has been documented by various research teams [1,10–13]. Spinner emphasized the significance of prompt diagnosis in a review of 14 cases [1]. Halpern outlined a clinical instance of compartment syndrome occurring in the hand of a 31-year-old patient following heroin injection [12]. Sawyer et al. discussed a case linked to an insect bite [10]. Another study described compartment syndrome arising from bleeding associated with a branch of the radial artery due to substantial displacement of a distal M2 fracture [13]. While metacarpal fractures are frequent, the emergence of secondary compartment syndrome is less common. Gong and Lu reported seven instances of compartment syndrome among 382 multiple metacarpal fractures, resulting in an incidence rate of 1.8% [14].

The hand contains three muscle compartments: the thenar, hypothenar, and interosseous compartments. Among these, the interosseous muscles are particularly susceptible to being cramped within their spaces. As indicated by Ling and Kumar in their anatomical study on cadavers, the first three dorsal interosseous muscles are entirely enclosed within their respective interosseous compartments, along with those of the thenar and hypothenar muscles [17].

Pressure measurements are crucial for objectively diagnosing compartment syndrome. According to Gong and Lu, a pressure exceeding 40 mmHg necessitates fasciotomy, even if clinical signs are absent [14]. However, the normal pressure values and the threshold for surgical intervention remain contentious. Matsen et al. argue that the critical pressure concept is of limited utility, as individual tolerance to pressure variations differs and is influenced by the limb's spatial position [18]. Conversely, Masquelet contends that clinical data alone are sufficient to justify fasciotomy [3]. Yet, multiple metacarpal fractures can complicate the assessment and necessary pressure measurements.

In our procedure, we performed neurolysis of the median nerve by cutting the anterior annular carpal ligament to alleviate paresthesias in the first three fingers, indicative of median nerve compression at the wrist, following the recommendations of Ouellette and Kelly [5]. However, Gong and Lu's team never performed this procedure, even with median nerve paresthesias, and they observed median nerve recovery within three months [14].

For osteosynthesis, we opted for intramedullary material, as the approaches we used precluded the use of plates. The literature does not indicate a clear preference for any specific technique in this scenario.

Conclusion:

by a solid aponeurosis. The thenar muscles are only inconsistently covered by a fascia. The hypothenar muscles are only covered by loose tissue, which could explain the low pressures we measured in our patient in these muscles. The pressure measurement in our clinical case found this significant difference in pressure between these muscles.

Compartment syndrome of the hand is a rare pathology that must not suffer from any delay in its treatment.

Indeed, if treatment is exclusively surgical, once begun, the phenomenon is irreversible: it's a "race against time" to break the vicious circle. Aponevrotomy should be performed within the first 6 hours at the most, based on clinical signs in all compartments. This is the only way to stop a critical increase in pressure. Incisions are left open and never initially closed. The need for median nerve neurolysis at the carpal tunnel or forearm dermo-fasciotomy may be discussed, in all cases, in acute forms.

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Figures:



Figure 1:Preoperative hand appearance



Figure 2: Preoperative X-ray

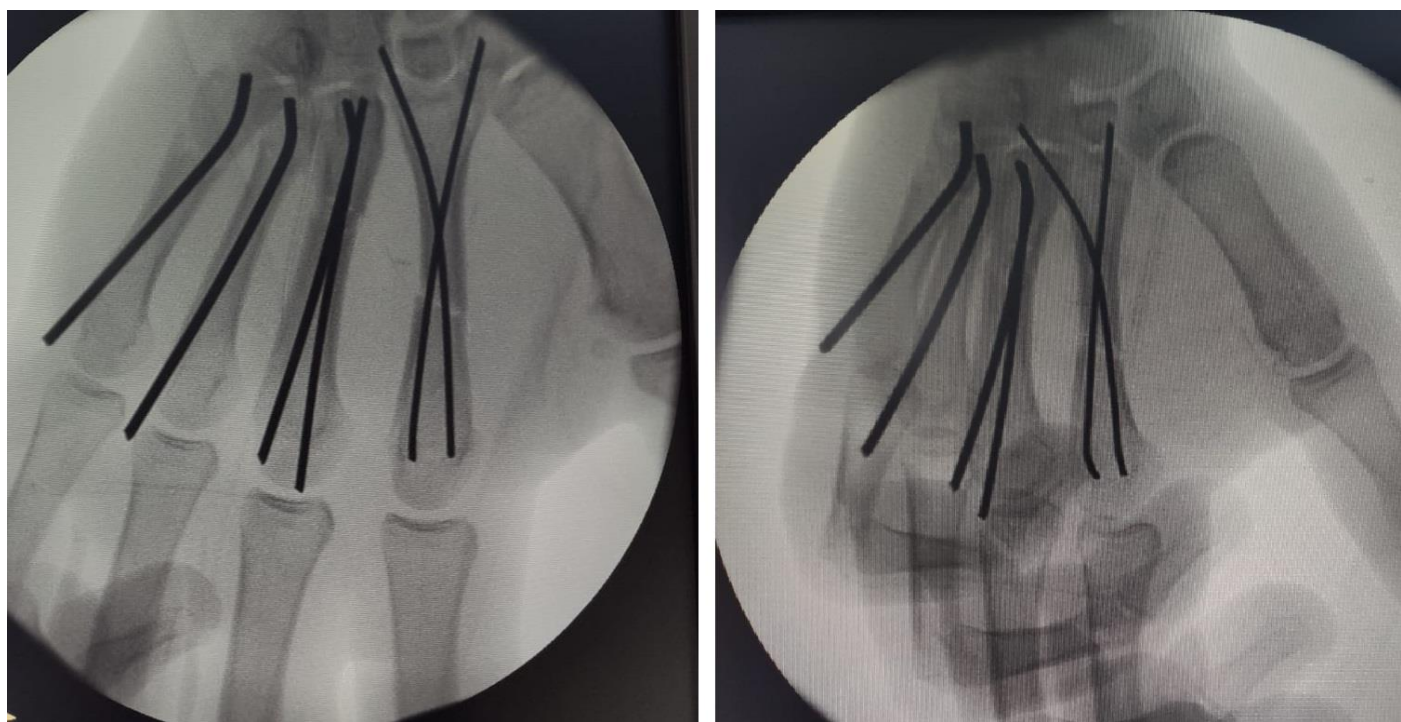


Figure 3: Post-operative scopic checks



Figure 4: Dermo-fasciotomies



Figure 5: Control X-rays

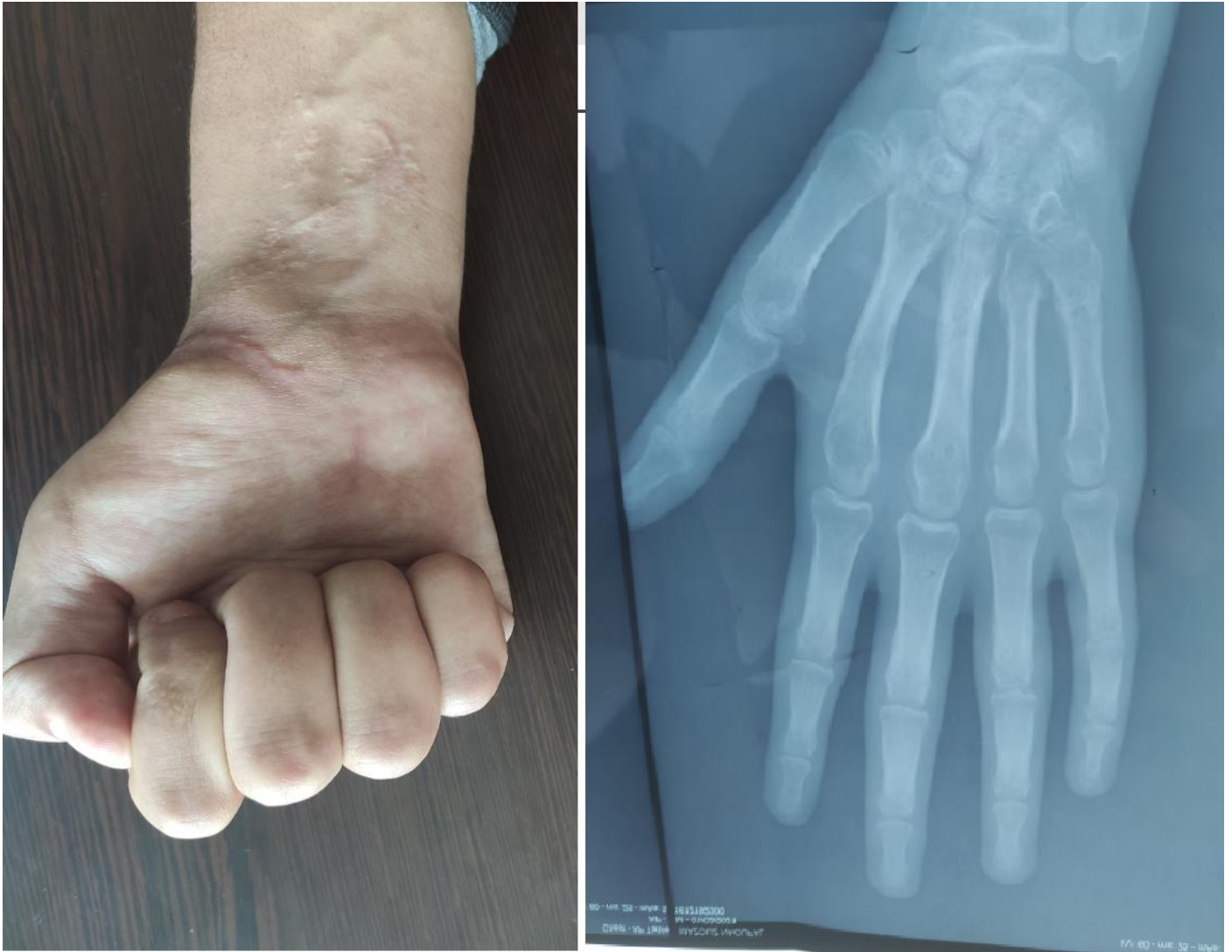


Figure 6: Clinical radiological control at the sixth month