Acute Compartment Syndrome of the Forearm Secondary to Infection Within the Space of Parona

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abstract

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The deep midpalmar space of the hand communicates with the space of Parona in the forearm. Infection of these deep spaces can be difficult to diagnose. This article presents the first reported case of acute compartment syndrome of the forearm secondary to infection within the space of Parona. This article discusses the anatomy of the space of Parona, highlighting its communicating spaces and the importance of recognizing a deep-space infection of the hand as a possible cause of compartment syndrome of the forearm. This article also suggests a method of clinical examination to aid in the diagnosis of infection within the space of Parona to allow more specific planning of surgical intervention through early decompressive surgery, with surgical exploration to exclude and drain infection when no other clear cause for the rise in pressure within the osteofascial compartment is apparent.
The deep midpalmar space of the hand communicates with the space of Parona in the forearm. infection of these deep spaces can be difficult to diagnose. This article presents a unique case of infection of the space of Parona in the absence of suppurative flexor tenosynovitis in an immunocompromised patient who presented with an acute compartment syndrome of the forearm. It also suggests a triad of clinical examinations to aid in the diagnosis of space of Parona infection.

The space of Parona extends from the proximal margin of the carpal tunnel to the mid-forearm. The roof is formed distally by flexor digitorum profundus tendons and proximally by the belly of the flexor digitorum superficialis. The origin of the flexor digitorum superficialis forms the proximal boundary of this space, which is limited medially by the flexor carpi ulnaris and laterally by the flexor pollicis longus. The floor is formed by the pronator quadratus distally and the interosseous membrane in its proximal two-thirds (Figure 1). To our knowledge, no specific clinical test exists that suggests infection within the space of Parona.

**CASE REPORT**

A 64-year-old woman with rheumatoid arthritis presented with a 3-day history of progressive pain and swelling that was initially noted in the thumb and hand that progressed to involve the distal volar forearm by admission. There was no history of trauma. The patient was taking naprosyn and methotrexate. The patient’s main complaint was pain. At presentation, she was febrile at 38°C, tachycardic with a heart rate of 101, and hypotensive with a blood pressure of 85/60 mm Hg. The patient had been passing dark, concentrated urine and had voided only 150 mL in the 6 hours since hospital admission.

Clinical examination revealed that the right hand was edematous with all the fingers held flexed (Figure 2). Blisters and associated motting of the skin were evident over the forearm and dorsally over the hand. There was no erythema, but edema of the hand extending into the mid-forearm was present. The hand was non-tender and had decreased global sensation. The dorsum of the hand had a large blister. The patient was unable to move her fingers, and any movement, especially passive extension of the fingers, caused severe pain in the forearm. Passive extension and flexion of the thumb at both the metacarpophalangeal and interphalangeal joints caused pain, with the discomfort being more significant at the latter. The peripheral pulses were minimally palpable, as the forearm was edematous. The forearm was tender and edematous but was not tense. Both pronation and supination of the wrist with the elbow flexed were painful, with pronation being markedly more uncomfortable for the patient. Elevation of the limb made the patient’s symptoms worse. Hematological investigation revealed the white blood cell count was only marginally elevated, and serum biochemistry revealed a C-reactive protein of 15. Genitourinary and respiratory causes of any sepsis were excluded.

In the operating room, forearm compartment pressures were measured using a handheld pressure monitor. Hand compartment pressures were not assessed as the hand was soft to palpate throughout.

The forearm compartment pressures were 23 (dorsal) and 35 (volar) mm Hg. Compartment syndrome of the forearm was diagnosed, and in the absence of common causes, this was believed to be secondary to deep-space infection. Emergency fasciotomy and decompression of the volar compartments of the forearm was planned.

Under general anesthesia, the volar aspect of the forearm was incised through the skin and deep fascia. Findings included gross subcutaneous edema. The forearm muscles were edematous, and the Palmaris longus muscle was necrotic, and hence excised (Figure 3). There was no pus in the superficial group of muscles. Further exploration revealed frank pus within the space of Parona extending into the midpalmar space of the hand but not extending proximally. The flexor retinaculum was fully divided. The first web space of the hand was also decompressed through a dorsal approach, as by this time, it was found to be tense in comparison with the previous time of measurement of compartment pressures. No further hand fasciotomies were performed, and the wounds were left open for further inspection. Group A Strep. group was sensitive to amoxicillin was cultured from intraoperative specimens taken from the space of Parona. Culture swabs taken from the proximal forearm and dorsum of the hand wounds were negative for any growth.

After initial decompression and drainage, the patient was admitted to the intensive care unit due to acute renal failure secondary to septic shock. She subsequently developed disseminated intravascular coagulation. After a period of intensive care, hemofiltration, hematological support, and intravenous antibiotic therapy, the patient’s condition gradually improved. She underwent further irrigation and wound debridement at 48 and 96 hours after the initial procedure. The patient was referred for any growth.

**Figure 1:** The space of Parona and its boundaries. 1, pronator quadratus; 2, space of Parona; 3, flexor carpi ulnaris; 4, flexor digitorum profundus; 5, median nerve; 6, flexor pollicis longus. **Figure 2:** Preoperative photographs of the right hand and forearm (A, B).
Infections of the deep subfascial spaces of the hand and wrist are relatively uncommon, but are well recognized. Potential sites for infection include the interdigital web space, dorsal subaponeurotic space, Parona’s space, thenar space, midpalmar space, and hypothenar space. Spread of infection from the adjacent and communicating midpalmar space and radial or ulnar bursae is the usual cause of infection within the space of Parona. A pyogenic flexor tendon sheath infection may extend proximally to involve the bursae and space of Parona.

Space of Parona infections present with swelling, tenderness, and occasionally fluctuance of the distal volar forearm. Similar findings may also be noted in the midpalmar region of the hand with the loss of the normal palmar concavity. The patient may also present with additional swelling, tenderness, and erythema of the fingers or thumb. Digital movements, specifically flexion, may be difficult and painful, particularly of the middle or ring fingers due to the interossei being paralyzed and surrounded by pus. However, these findings do not aid in specifically locating the infection to the space of Parona. To our knowledge, no specific examinations exist that locate infection to within the space of Parona. Based on observations in this case, we advocate early documentation and examination of the following:

1. Decrease in pronator quadratus strength on resisted wrist pronation with the elbow flexed beyond 90°. (Passive flexion of the elbow past 90° significantly decreases the contribution of pronator teres to wrist pronation as it is lax with the elbow in this position.)
2. Pain and decreased power on active use (or passive stretch) of flexor pollicis longus. (Immobilize the metacarpophalangeal joint in extension. The flexor pollicis longus is isolated and is responsible for flexion of the interphalangeal joint of the thumb.)
3. Reduced power and range of wrist volar flexion plus minus specific decrease in concomitant wrist abduction (suggesting decrease in power/loss of flexor carpi ulnaris).

The above triad of tests is aimed at testing 3 of the 4 boundaries of the space of Parona, which would be irritated by pus within the space. The flexor digitorum profundus and flexor digitorum superficialis tendons would also be irritated, demonstrated through reduced and painful finger movements. However, these tendons could also be irritated by infections in other spaces within the upper limb, and examination findings concerning them would be less specific for infection in the space of Parona, but should not be discounted completely.

Acute compartment syndrome occurs when raised pressure within a closed osteofascial compartment compromises the circulation and function of tissues within the compartment. The forearm is the most common site for compartment syndrome in the upper extremity. Most cases are caused by diaphyseal forearm and distal radius fractures. Those at risk of developing compartment syndrome also include patients with bleeding disorders and those on anticoagulant therapy. None of these common causative factors were noted in our patient.

Infection presenting as compartment syndrome in the forearm is rare. There are cases of compartment syndrome in the pediatric forearm believed to be secondary to acute hematogenous osteomyelitis of the ulna. In a retrospective analysis of 263 patients, Schnall et al described 4 patients who had compartment syndrome directly associated with infection, with 3 of 4 patients growing Group A Streptococcus on initial culture. There are no reported cases of a deep space infection of the forearm presenting as compartment syndrome.

In our experience, due to extensive swelling and features of early compartment syndrome, the exact location of the infected compartment was difficult to ascertain. However, the clinical findings specific to the boundaries of the space of Parona raised suspicion of the infection lying within this space. Due to the patient’s septic load, level of decompensation, and continuing clinical deterioration,
radiological imaging was not deemed appropriate. However, we would advocate radiological investigation for appropriately selected patients, specifically those without compartment syndrome or sepsis.

Management of infection involves rest, elevation, surgical drainage, and appropriate systemic antibiotic therapy. However, suppurative deep-space infection is treated primarily with surgical drainage in association with these other therapies. Several alternative surgical approaches have been described, but selection is based on the extent and precise location of the infection and surgeon preference. The planning and placement of the surgical incision should be undertaken carefully to avoid damage or leaving the superficially located median nerve without adequate soft tissue coverage. Drainage of the space of Parona may be performed adequately through a curvilinear or longitudinal forearm incision placed directly over the flexor tendons and ending proximal to the wrist flexion crease. If, as in our case, there is an associated midpalmar infection, an extensile approach with release of the transverse carpal ligament or 2 separate incisions with preservation of the ligament may be used.

Compartment syndrome of the forearm is a serious medical problem. Timely recognition and treatment are critical to ensuring a good outcome and avoiding permanent functional loss. As in our case, patients with systemic hypotension do not require significant elevation of the compartment pressures to produce symptoms of compartment syndrome. Surgical intervention with decompressive fasciotomy remains the treatment.

Aggressive hand therapy is usually required in the postoperative period to avoid the complication of tendon adhesions, joint contractures, and hand stiffness. The surgeon must recognize the pertinent anatomy and how this influences the behavior of specific types of infections, the role of immunocompromise, and the importance of early mobilization.

This case highlights the need for extra vigilance and a lower threshold for suspicion of infection in immunosuppressed patients despite the absence of both clear clinical signs of infection and an infective source within the forearm. This case is also the first of its kind, demonstrating the development of acute compartment syndrome secondary to an infection in the space of Parona. In such cases, we advocate our triad of specific clinical tests to be used with the general findings associated with deep space infection in the upper limb in an attempt to locate the suspected offending area of infection and allow more specific planning of surgical intervention through early decompressive surgery, with surgical exploration to exclude and drain infection when no other clear cause for the rise in pressure within the osseofascial compartment is apparent.

**REFERENCES**