

Acute Compartment Syndrome of the Hand

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Disclosures for this Article

Editors

David C. Ring, MD, has no relevant conflicts of interest to disclose.

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All authors of this journal-based CME activity have no relevant conflicts of interest to disclose. In the printed or PDF version of this article, author affiliations can be found at the bottom of the first page.

Planners

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Learning Objectives

- Compare the clinical manifestations of acute compartment syndrome of the hand and forearm.
- Review the evidence pertinent to the diagnosis of compartment syndrome of the hand.
- Discuss the shortcomings of the evidence related to diagnosing acute compartment syndrome of the hand.
- Assess the methods of pressure measurements for compartment syndrome of the hand.
- Offer strategies for diagnosing cases with unclear or borderline compartment syndrome of the hand.

Deadline: Each examination purchased in 2015 must be completed by January 31, 2016, to be eligible for CME. A certificate will be issued upon completion of the activity. Estimated time to complete each JHS CME activity is up to one hour.

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THE PATIENT

A 35-year-old male laborer presented to the emergency department with pain and swelling in his hand after a crush injury. Radiographs did not demonstrate any fractures. His blood pressure at the time of examination

was 145/70 mm Hg. He described the pain as extreme. He denied any numbness. On physical exam, the diffuse swelling of his hand was found to be tense. Vascular exam noted capillary refill that was approximately 2 seconds. Passive adduction and abduction of the fingers at the extended metacarpophalangeal joints resulted in pain. Intracompartmental pressures of 30 mm Hg were measured.

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THE QUESTION

What symptoms, signs, and pressure measurements are diagnostic of compartment syndrome of the hand?

CURRENT OPINION

Compartment syndrome is one of the most important diagnoses in orthopedic surgery. Timely diagnosis can



prevent muscle necrosis, which can lead to severe permanent functional impairment and kidney damage. Compartment syndrome of the forearm is diagnosed based on pain out of proportion to the injury, pain with passive stretch of the extrinsic finger flexors, the progressive development of objective neurologic dysfunction, and potentially, Volkmann's ischemic contracture.^{1,2} In contrast, compartment syndrome of the hand is usually considered when the hand is significantly swollen in a context where it is difficult to determine if there is more pain than would be expected from a certain injury (eg, a crushed hand or altered sensorium), with no neurological dysfunction expected, and therefore there are limited objective criteria to assist in diagnosis. Criteria used to support a diagnosis of compartment syndrome of the hand include the extent of swelling, compartment tension by palpation, and pain intensity.³⁻⁶ These criteria are nonspecific and likely unreliable and inaccurate. Some surgeons therefore rely more on objective intracompartmental pressure measurement, but the threshold pressure for diagnosis of compartment syndrome in the hand is debated.^{3,4}

THE EVIDENCE

Compartment syndrome of the hand can result from trauma, drug overdose leading to crush syndrome, crotalid envenomation, and insect bites.^{3,6-11} The ability of extravasation of intravenous fluids and bleeding diatheses to cause compartment syndrome in the hand is debatable.^{3,7,8,12,13}

Halpern et al described the most sensitive clinical sign for compartment syndrome of the hand as pain with passive motion at the metacarpophalangeal joint corresponding to the affected intrinsic musculature.⁴ In addition, they used an intracompartmental pressure threshold of 50 mm Hg to confirm the diagnosis, as described by Whitesides et al.¹⁴ The authors concluded that this is the threshold at which tissue necrosis begins to develop without decompressive fasciotomy in the normotensive patient. In addition, Whitesides et al noted that in a canine study by Rorabeck et al and another study by Ashton, tissue perfusion is decreased when the intracompartmental pressure is within than 10 to 30 mm Hg of the diastolic blood pressure.¹⁴⁻¹⁶

Ouelette and Kelly felt that a tense swollen hand with intrinsic minus position was sufficient for diagnosis and suggested a threshold pressure of 15 to 25 mm Hg with clinical symptoms or 25 mm Hg without symptomatology. A justification for these relatively low pressure thresholds was not given. The

majority of their patients had an obtunded sensorium, limiting the examination.³

Shuler and Dietz noted that palpation (ie, *tense compartments*) had a sensitivity of 24%, a specificity of 55%, and positive and negative predictive values of 19% and 63%, respectively, in the diagnosis of compartment syndrome in the leg.¹⁷ Similarly, Ulmer also found poor reliability, noting that the sensitivity of clinical findings (pain, pain with passive stretch, paresthesias, and paresis) as a whole is only 13% to 19%, with a positive predictive value of 11% to 15% for accurately diagnosing compartment syndrome in the lower extremity.¹⁸

Guyton et al, in a cadaveric study, found that there are no true anatomic barriers between adjacent interosseous compartments. Rather, between each dorsal and volar interosseous compartment there exists a thin tissue barrier that becomes incompetent at pressures lower than 15 mm Hg.¹³ In another anatomic study, DiFelice et al found variability in the compartmentalization of the thenar and hypothenar myofascial spaces in 52% and 76% of specimens, respectively. In each of these specimens, two discrete subcompartments were identified.¹⁹ The clinical effect of this subcompartmentalization on the measurement of compartment pressures and the treatment of hand compartment syndrome is unknown.

Current evidence shows that the Whitesides manometer demonstrates unacceptably high scatter and lacks the precision needed for useful clinical application, with a correlation coefficient of 0.9115 between actual and measured pressures. Arterial line manometers are far more reliable, with a correlation coefficient of 0.9978. The Stryker system (Mahwah, NJ) has been shown to be quite accurate and is less user-dependent with the least constant bias.²⁰ It has been noted by Moed and Thornderson that straight needles are less accurate in pressure measurement techniques than both side-port needles and slit catheters, demonstrating a mean overestimation of compartment pressure by 19.3 and 18.3 mm Hg, respectively. These findings were echoed by the work of Boody and Wongworawat.^{20,21}

A canine study by Matava et al demonstrated a dependence on diastolic pressure, with 20 mm Hg below the diastolic pressure critical to the development of ischemic muscle necrosis.²² An additional study in a canine model, by Heppenstall et al, described the normal cellular metabolic state of healthy tissue to exist at 30 mm Hg.²³

SHORTCOMINGS OF THE EVIDENCE

Hand compartment syndrome is uncommon and difficult to study. Current evidence regarding the presentation, clinical examination, and diagnosis of

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