

Acute Exertional Compartment Syndrome of Bilateral Upper Extremities After a Push-up Contest

Corey J. Schiffman, MD
Robert P. Dunbar, MD
Reza Firoozabadi, MD

From the Department of Orthopedics and Sports Medicine, University of Washington, Seattle, WA.

Correspondence to Dr. Schiffman: cjschif@uw.edu

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Abstract

Acute exertional compartment syndrome (AECS) involving the upper extremity is a rare form of compartment syndrome that occurs after physical activity. Despite its infrequent occurrence, AECS has devastating sequelae, including muscle necrosis and nerve injury. It is imperative to promptly evaluate for AECS in any patient who has notable pain and sensory changes in the context of recent physical activity because of the dire consequences of a missed diagnosis. A 34-year-old man presented to the emergency department with excruciating pain and diffuse paresthesias in his bilateral arms and forearms after participating in a push-up contest. He also had pain with passive stretch of his triceps. Because of these physical examination findings and uncontrollable pain, a clinical diagnosis of AECS was made and was managed with fasciotomies. Postoperatively, the patient's pain and paresthesias slowly resolved, and he was eventually able to return to work at full capacity as a construction worker. This example of AECS of bilateral upper extremities emphasizes that it is a condition that, although rare, is real and must be taken seriously. With appropriate clinical suspicion, a prompt diagnosis can be made, and potentially devastating consequences can be avoided.

Acute exertional compartment syndrome (AECS) consists of decreased tissue perfusion secondary to elevated intrafascial compartment pressure after physical activity. While traumatic compartment syndrome is well documented, AECS is less well described, most notably involving the upper extremities. Furthermore, because of its rarity, it is easy to misdiagnose AECS, leading to potentially

catastrophic sequelae. More commonly seen in the leg, descriptions of AECS involving the upper extremities are limited to a small number of case reports.¹⁻⁶ We present a case detailing AECS of bilateral upper arm and forearms to increase the awareness of this rare, highly morbid, but treatable condition. If recognized and managed promptly and appropriately, devastating consequences may be avoided.

Case Report

A 34-year-old man presented to the emergency department complaining of excruciating pain in his bilateral posterior upper arm and forearms 24 hours after he reportedly did 250 consecutive push-ups in a contest. He described his pain as 10/10, localized from his bilateral pectoralis muscles down to his forearms. He denied resting in one position for a prolonged period of time.

He was tachycardic with heart rate of 100 to 109, but was afebrile and normotensive. Laboratory values were notable for a creatinine kinase of 45,084 U/L (normal, 62 to 325) and urine toxicology was positive for cocaine, which he admitted to consuming the night before his push-up contest. He was then admitted to the internal medicine service for management of rhabdomyolysis and was started on intravenous lactated Ringer's solution at a rate of 250 mL/hr.

The orthopaedic service was consulted when his pain continued to worsen and was poorly controlled despite an increasing pain medicine requirement. He described his pain as markedly worsened with both active and passive movement of his shoulders, elbows, wrists, and fingers. He also endorsed paresthesias in his radial, median, and ulnar nerve distributions bilaterally.

Upon evaluation on the medical ward, the patient was found to be in visible distress secondary to pain. On examination, both extremities were diffusely tense and swollen. He was exquisitely tender to palpation throughout the upper extremities, but particularly over the triceps muscle. In both extremities, light touch sensation was diminished but not completely absent throughout the median, radial, and ulnar nerve distributions. Motor examination testing revealed that he had 4/5 strength in the distributions of his median,

anterior interosseus, radial, posterior interosseus, and ulnar nerve distributions, bilaterally. On the right upper extremity, he was only able to perform active elbow flexion and extension through an arc of 10° (from 20° to 30° of flexion) limited by pain and had severe discomfort with passive elbow flexion greater than 30° of flexion. Similarly, on the left upper extremity, he was only able to perform active elbow flexion and extension through an arc of 30° (from 15° to 45° of flexion) and was only able to tolerate passive elbow flexion from 0° to 45° of elbow flexion. His fingers were warm and well perfused with palpable radial pulse.

Based on these physical findings, a clinical diagnosis of compartment syndrome was made. Compartment pressure measurements were not obtained because of the compelling clinical picture of compartment syndrome. He was emergently taken to the operating room where bilateral upper arm and forearm fasciotomies and carpal tunnel releases were performed. The incision began at the carpal tunnel, extended proximally to the antecubital fossa, and curved radially to adequately release the mobile wad.⁷ A separate 16-cm incision directly over the triceps was used to release the posterior compartment of the upper arm. The anterior upper arms and pectoralis were not released, as they remained soft and compressible.

On incising the posterior arm and superficial volar forearm fascia, rapid herniation of the muscle was observed. After the release of his upper extremity compartments, all muscles appeared of healthy color and consistency, were contractile, and had capillary bleeding. The incisions were left open, a negative pressure wound therapy device was applied and he was placed in posterior arm splints for soft-tissue rest.⁷

Six hours after surgery, he described an improvement in pain but

continued to endorse diminished sensation in all of his nerve distributions. On postoperative day 1, his pain continued to decrease and his sensation returned to baseline except diminished in the distribution of his left ulnar nerve.

On postoperative day 2, he underwent delayed primary closure of his bilateral fasciotomies. The muscle continued to appear healthy and contractile and only required a small amount of debridement in the right volar forearm. His incisions were successfully closed under moderate tension using the Allgöwer modification of the Donati stitch.⁸

On postoperative day 1 after his delayed primary closure, he continued to endorse diminished sensation in his left ulnar nerve distribution, but experienced near resolution of pain. He then underwent an uncomplicated hospital course and was discharged home on postoperative day 4 from his delayed primary closure. At discharge, he continued to have 4/5 strength bilaterally in all distributions and had improved but continued slightly diminished sensation in the left ulnar nerve distribution.

At his 4-week follow-up, he had bilateral elbow range of motion from 10° to 140° without pain. He had hyperesthesia in his bilateral ulnar nerve distribution but otherwise had intact sensation. He had normal strength except for bilateral 4/5 grip strength. He was released to work as a construction worker at light-duty capacity. However, one week later, he returned to work at full-duty capacity when his hyperesthesia resolved.

He then cancelled his 8-week follow-up appointment when he was functioning at work without issue. He was contacted through telephone at 7 months postinjury, and he described working a busy construction job without complaints except for occasional hyperesthesia in bilateral ulnar distributions.

Discussion

Acute compartment syndrome is a condition consisting of increased pressure within a closed fascial space, which compromises the perfusion to the tissues of that fascial compartment.⁹ Tissue perfusion has been shown to be proportional to the difference between the capillary perfusion pressure and the interstitial fluid pressure.¹⁰ Therefore, compartment syndrome can occur with any elevation of interstitial pressure and can lead to perfusion that is below the level necessary to maintain viable tissue. This can lead to devastating consequences including muscle necrosis, nerve injury, amputation, renal failure, and death. Compartment syndrome is often precipitated by trauma, with the most common factor being extremity fractures.¹¹

Less commonly, compartment syndrome can also be precipitated by exertion. Rorabeck et al¹⁰ provide a two-part explanation for exertional compartment syndrome. First, with muscle contraction, muscle volume increases by 20%, increasing the pressure within the compartment. And second, exercise results in a simultaneous increase in capillary hydrostatic pressure and interstitial osmotic pressure, causing a fluid shift from intravascular to the interstitium, thus increasing the interstitial pressure. Exertional compartment syndrome can be divided into two subtypes: chronic and acute. Chronic exertional compartment syndrome is associated with moderately elevated compartment pressures and pain that characteristically resolves with rest.¹² In contrast, AECS is caused by a rapid increase in compartment pressure, leading to decreased tissue perfusion that threatens the viability of the limb, often leading to irreversible damage that persists and progresses despite rest.

The rare occurrence and unusual presentation of AECS has historically

led to difficulties in making this diagnosis, which has led to devastating complications.¹³ Although there have been many case reports detailing AECS of the lower extremity, AECS involving the upper extremity is less commonly and less well described. In fact, there are only a few case reports describing AECS of the forearm.¹⁻⁵ Dhawan et al detailed a case report of unilateral forearm AECS in a patient who developed symptoms after beginning a new job as a cake decorator.¹ There have also been three case reports describing isolated AECS of the extensor carpi ulnaris after repeated forearm and wrist movements, such as using a hammer.³⁻⁵ Oh et al⁶ performed a descriptive epidemiology study after a group of high school football players developed acute exertional rhabdomyolysis and triceps compartment syndrome after upper extremity exercises. Of 43 players on the team, three developed triceps compartment syndrome.

The patient described in this case report details another example of a rare but highly morbid condition. Regarding his cocaine use, although he denied intoxication during his push-ups, he might not have been truthful. Recent use might have caused a sense of euphoria and decreased perception of pain, increasing the amount of push-ups that he could typically achieve. This overexertion might have predisposed him to develop AECS.

Nevertheless, the clinical diagnosis was made due to the patient's concerning symptoms consistent with compartment syndrome, most notably progressively worsening pain despite a typically adequate pain regimen and pain with passive stretch of his triceps muscle. The diagnosis was then confirmed by the billowing force of the muscles from their compartments as the fascia was incised. The patient then began experiencing an improvement in pain and gradual

return in sensation and motor strength after the fasciotomies. With appropriate awareness and clinical suspicion, an early and accurate diagnosis can be made, allowing for prompt treatment to prevent further potentially devastating injury.

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