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Exercise-induced bilateral upper-arm anterior and posterior compartment syndrome with rhabdomyolysis

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Acute compartment syndrome is defined as increased pressure in a compartment that leads to a decrease in perfusion pressure.[10] Rhabdomyolysis is defined as a syndrome of skeletal muscle damage with release of toxic intracellular material into the body systemically and is often caused by trauma.[6] Exercise-induced compartment syndrome with rhabdomyolysis is rare, especially in the upper arm.[1,10] The majority of cases of compartment syndrome present in the lower extremities and are usually due to trauma. Exercise-induced lower-extremity compartment syndrome has been reported in activities such as indoor cycling.[3] Upper-extremity compartment syndrome from exercise has been reported and has usually been seen within 1 compartment.[4,7-9] Bilateral upper-arm compartment syndrome with rhabdomyolysis is very rare, and only a small number of cases have been reported in the literature.[1,10] The diagnosis and treatment of both compartment syndrome and acute rhabdomyolysis are very important, and prompt care is essential for limb and patient survival. We present the first known case report of exercise-induced bilateral upper-arm anterior and posterior compartment syndrome with rhabdomyolysis in a well-conditioned individual who regularly takes part in CrossFit competitions (CrossFit, Washington, DC, USA).

Case presentation

A 37-year-old, right hand–dominant male anesthesiologist presented to the emergency department with severe bilateral upper-arm pain, swelling, and decreased motion of the elbows, as well as hematuria. He also complained of bilateral median nerve paresthesias that were worse with elbow extension. The symptoms had progressively worsened with no improvement over a 24-hour period after an intense CrossFit competition, and thus, the patient presented for evaluation and treatment. The CrossFit competition was composed of a 1.6-km (1-mile) run, 100 pull-ups, 200 push-ups, and 300 body-weight squats, followed by a 1.6-km (1-mile) run to finish. The patient had never previously participated in this amount of exercise during a single workout. He also admitted to heavy alcohol use the 2 days before the competition, without much hydration prior to it.

On examination in the emergency department, the patient had very swollen bilateral upper arms with tense compartments, both anterior and posterior. The forearm compartments were soft. He had pain with passive stretch to the elbows in both flexion and extension. Increased median nerve paresthesia was noted with passive extension of the elbows. The laboratory results revealed a total

It should be noted that the second author of this article is also the patient described in this case report.

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creatine kinase level of 89,527 and myoglobin level of 8548. Urinalysis revealed a large amount of blood and protein. The patient was treated with intravenous fluids, pain control, and close observation in the emergency department. After an orthopedic consultation, he received a diagnosis of bilateral arm compartment syndrome of the anterior and posterior compartments and was taken to the operating room for bilateral upper-arm fasciotomy of the anterior and posterior compartments. This was performed with the patient under general anesthesia. As soon as the fascia was released, the muscle bulged from both compartments in both arms. The muscle had a dusky appearance that improved immediately after release. The muscle had a good response to manual and electrical stimulation. The skin was closed, and the patient was admitted to the hospital floor for 5 days, receiving intravenous fluids and medical treatment for severe rhabdomyolysis. He was followed up until 2 years postoperatively and fared very well. He returned to full active work as an anesthesiologist 7 days after surgery. He returned to cross-training at 6 weeks from surgery and returned to CrossFit competitions without a permanent decrease in strength or endurance. Hypertrophic scarring of both incisions developed, but no other complications occurred. No permanent renal damage developed.

Discussion

It is well described that compartment syndrome and rhabdomyolysis can develop from causes such as trauma, surgery, anticoagulation, and immobilization. Trauma is by far the main cause of both compartment syndrome and rhabdomyolysis.[2] However, these conditions can present from exercise in both patients who are well-conditioned athletes and those who are not. The majority of exertional rhabdomyolysis cases result from exercise, specifically strength training.[2] Feito et al[5] looked at >3000 cross-training athletes and reported on their injuries. The majority of injuries were in the upper extremity, and the authors found that participants who engaged in this type of exercise <3 days/week and those in their first year were more prone to the development of injury. However, only 0.6% of these cases were exertional rhabdomyolysis cases.

Bilateral upper-arm compartment syndrome with rhabdomyolysis is very rare, and just a few cases have been reported. Single-compartment involvement has been reported more often but is still not common. Ejnisman et al[4] reported a case of distal biceps rupture in an athlete presenting with compartment syndrome of the upper-arm anterior compartment without use of anticoagulation. A case reported by Traub et al[10] showed a similar type of presentation to our case with bilateral arm involvement but in a patient who did 100 push-ups and was not a regular athlete. Aynardi and Jones[1] described a patient who presented with bilateral upper-arm anterior-only compartment syndrome with rhabdomyolysis after a vigorous cross-training workout. Our case presentation is unique as the patient had upper-arm compartment syndrome of both the anterior and posterior compartments with rhabdomyolysis and was a highly experienced and competitive athlete. Dehydration from alcohol use and inadequate water intake before and during the athletic competition surely contributed to the development of rhabdomyolysis in this patient.

Conclusion

Compartment syndrome of the anterior and posterior compartments of the upper arm can develop in well-conditioned individuals who compete in CrossFit, and this should be considered in a patient presenting with such signs and symptoms from a recent workout. We furthermore stress the importance of adequate hydration and avoidance of alcohol use in the time frame immediately before and after a workout or competition, especially during cross-training, and if this scenario exists with symptoms, there should be a high suspicion of compartment syndrome that can lead to rhabdomyolysis.

Disclaimer

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References

1. Aynardi MC, Jones CM. Bilateral upper arm compartment syndrome after a vigorous cross-training workout. J Shoulder Elbow Surg 2016;25:e65-7. https://doi.org/10.1016/j.jse.2015.11.061
2. Bäcker HC, Busko M, Krause FG, Exadaktylos AK, Klukowska-Roetzler J, Deml MC. Exertional rhabdomyolysis and causes of elevation of creatine kinase. Phys Sportsmed 2020;48:179-85. https://doi.org/10.1080/00913847.2019.1669410
3. DeFilippis EM, Kleiman DA, Derman PB, DiFelice GS, Eachempati SR. Spinning-induced rhabdomyolysis and the risk of compartment syndrome and acute kidney injury: two cases and a review of the literature. Sports Health 2014;6:333-5. https://doi.org/10.1177/1941738114522957
4. Ejnisman C, Santoro Belangero P, Vicente Andreoli C, de Castro Pochini A, Cohen M, Ejnisman B. Compartment syndrome after distal

biceps brachii tendon rupture in an athlete. Einstein (Sao Paulo) 2020; 18:eRC4778. https://doi.org/10.31744/einstein_journal/2020rc4778
5. Feito Y, Burrows EK, Tabb LP. A 4-year analysis of the incidence of injuries among CrossFit-trained participants. Orthop J Sports Med 2018;6. https://doi.org/10.1177/2325967118803100.
6. Misirli G, Hatzitolios AI, Giannoglou GD. The syndrome of rhabdomyolysis: complications and treatment. Eur J Intern Med 2008;19: 568-74. https://doi.org/10.1016/j.ejim.2007.06.037
7. Oh J, Laidler M, Fiala SC, Hedberg K. Acute exertional rhabdomyolysis and triceps compartment syndrome during a high school football camp. Sports Health 2012;4:57-62. https://doi.org/10.1177/1941738111413874
8. Ozyurek S, Kose O. Distal biceps brachii tendon rupture resulting in acute compartment syndrome. Orthopedics 2014;37:147. https://doi.org/10.3928/01477447-20140225-02
9. Segan DJ, Sladek EC, Gomez J, McCoy HJ, Cairns DA. Weight lifting as a cause of bilateral upper extremity compartment syndrome. Phys Sportsmed 1988;16:73-5.
10. Traub BC, Lane MK, Traub JA. Exercise-induced acute bilateral upper-arm compartment syndrome. Case Rep Emerg Med 2017;2017: 9454782. https://doi.org/10.1155/2017/9454782