Chronic Exertional Compartment Syndrome in a Healthy Young Man

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Abstract

Objective: The purpose of this case report is to describe a patient who presented with symptoms of exercise-induced compartment syndrome and was later referred for bilateral fasciotomy surgery.

Clinical Features: A 21-year-old patient presented for chiropractic care with the inability to run due to foot paresthesia and weakness. An exertion test and compartment pressure test diagnosed exercise-induced compartment syndrome. Exertion test and compartment pressure test were used to identify and diagnose exercise-induced compartment syndrome.

Intervention and Outcome: The patient was diagnosed with exercise-induced compartment syndrome. He was treated conservatively and referred for additional testing. The orthopedic surgeon requested that 12 weeks of conservative care be provided prior to testing; treatment consisted of chiropractic care and rehabilitation exercises. Following the 12 weeks of treatment, the patient did not significantly respond to conservative care. A compartment pressure test confirmed the initial diagnosis of exercise-induced compartment syndrome. The patient underwent a unilateral fasciotomy surgery and recovered fully. Following the surgery, the patient returned to the chiropractic clinic with the same presentation in the contralateral leg. The same protocol of management resulted in the same outcome. Two years after surgical intervention, the patient continues to maintain an active lifestyle, able to run 2 to 3 miles per day without any exacerbations or symptomatology.

Conclusion: Clinical awareness, a detailed history, and thorough examination with reproduction of symptomatology are necessary to form a proper diagnosis and treatment plan for these patients. Therefore, multidisciplinary medical communication would prove to be the most beneficial approach for the patient.

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Introduction

Exercise-induced compartment syndrome of the lower extremity affects athletes who increase activity levels in both intensity and duration. One theory explains the reasons for the condition such as vascular compromise and ischemia due to the muscular pressure raises from increased exercise demands.¹⁻⁷

Chronic exertional compartment syndrome (CECS) is a reversible ischemic state that is secondary to a noncompliant osseofascial compartment. During exercise, there is an elevated demand from the muscle for oxygen with increasing the blood flow to the muscle. This causes the muscle to swell. In compartment syndrome, a fascial restriction by the sheaths of the connective tissue surrounding the various levels muscle fibers limits muscle expansion and decreases blood flow to the region as well. The muscle then reacts to the oxygen deprivation with the signs and symptoms of muscle cramping, pain, and/or weakness, which may lead to severe disability in the affected extremity.^{2,8-15}

It is currently hypothesized that, in CECS, exercise increases intramuscular pressure, resulting in symptoms. Chronic exertional compartment syndrome is more prominent in athletes who participate in sports or activities that involve repetitive impact such as running or fast walking.

Overuse injuries are the result of repetitive micro-trauma, leading to damage that occurs to the intra- and intercellular tissue. The changes that occur from the microtrauma damage can range from the formation of scar tissue to tissue degeneration. These changes have been observed in athletes following an increase in training intensity and/or duration. Therefore, CECS and other overuse injuries typically occur when performance training increases at a rate faster than the body can adapt. Some of the conditions to consider for differential diagnosis of CECS include intermittent claudication, lumbar disk herniation, stress fracture, medial tibial stress syndrome, muscle strain, and tibiofibular joint dysfunction.^{2,4,8,12,16-22}

The purpose of this case report is to describe the presentation and management of CECS in a 21-year-old man.

Case Report

A healthy 21-year-old man initially presented to a chiropractic office with a chief concern of pain in the sole of the left foot. The pain was intermittent,

nontraumatic gradual onset for the previous 2 months. The pain was worse after rest, especially first thing in the morning. The patient stated that, previously, he was in a marching band which practices for multiple hours per day and, currently, he was training aerobically in preparation for entrance into the Air Force boot camp. For the previous 3 months, the patient had been running several miles per day and working out to an exercise program that included frequent high-impact intensity jumps for 1 hour per session.

The patient described that during marching band, he was instructed to march by lifting his feet straight up and down, with minimal dorsiflexion or plantar flexion. By walking in this manner, there were decreased shock absorption and increased stress to the kinetic chain. Additional stress from running and jumping resulted in cumulative negative effects leading to soft tissue derangement and chronic tissue injury. The patient also stated that he experienced increased difficulty during running due to pain in the left lower leg. The patient would cease activity after 8-10 minutes, with all symptoms dissipating 5 to 10 minutes after activity ended. The first episode was noted 8 weeks prior while training on hard pavement, and the patient denied any pain while walking during daily activity.

When the pain developed during activity, it would radiate from the midpoint of the anterior lower leg down to the dorsum of the foot, leading to a dorsiflexion weakness developing. Following the development of the left lower leg symptomatology, the patient was examined before and after exertion. To accomplish this, the patient was instructed to restrict his training for 24 hours prior to the examination. During the initial examination, there were no abnormalities noted, and his left lower extremity was not swollen, with no pain or weakness noted. The patient maintained muscle strength during examination. The patient was able to perform functional activities, which included gait assessment, squatting, vertical jump, and stair climbing, without pain or symptomatology.

An active examination was performed on the treadmill with the patient running at a similar pace and intensity to his routine training session. The patient developed pain and weakness in the left tibialis anterior muscle after 6.32 minutes of running, and the patient was instructed to discontinue activity and the physical examination was reperformed.

During the examination, the patient described the pain as a "Charlie horse" sensation. Observation of the left lower extremity becoming swollen was measured from 37.5 to 44.9 cm. The dorsalis pedal and posterior tibia pulses were decreased on the left with reduced

sensation to light touch and reduced sharp/dull differentiation on the dorsum of the left foot.

There were tenderness to direct palpation along the tibial ridge and exacerbation of symptoms with passive flexion of the toes in dorsiflexion. The patient had full range of motion of the knee and decreased ankle eversion with an increase in pain and paresthesia over the tibialis anterior, midtibial shaft, and dorsum of the foot. The leg and foot remained warm to the touch. The patient demonstrated 2 of 5 muscle strength of left lower leg with an increase in pain from 0 of 10 to 8 of 10 with passive great toe flexion. All symptoms dissipated within 12 minutes after ending activity.

Based on the findings of the physical examination before and after activity, the patient's working diagnosis was CECS. A bone scan and magnetic resonance imaging of the left tibia were obtained to help rule out any underlying physiopathology and showed no evidence of stress fracture or periostitis.

To confirm the diagnosis of compartment syndrome, the patient was referred to an orthopedic surgeon to be tested for intracompartmental pressure test. This is the definitive test and the criterion standard for making the diagnosis of exercise-induced compartment syndrome.^{18,22-26}

The orthopedic surgeon chose to continue conservative therapy for 12 weeks prior to considering the patient for an initial diagnostic testing.

Conservation care included instrument-assisted muscle release and combination ultrasonography followed with cryotherapy. The patient was educated and instructed by the chiropractor in the possible risk of the compartment pressure to continue to rise. The patient was instructed in the case of symptomatology to be for prolonged time becoming a surgical immediate intervention. The patient was explained the possible tissue irreversible damage that may manifest after prolonged ischemia spanning for more than 3 hours.

Following the recommended 12 weeks of conservative care, a compartment test pressure monitoring test ordered by the chiropractor confirmed the diagnosis of intracompartmental pressure increase in the anterior and lateral compartments of the left leg, with a minimal increase of the posterior compartment. The results of the compartment test indicated an anterior compartment pressure of 33 mm Hg and posterior compartment pressure of 42 mm Hg postactivity vs 17 and 22 mm Hg in the respective compartments preactivity. Note, a resting pressure ≥ 15 mm Hg and 5-minute postexercise pressure ≥ 20 mm Hg are diagnostic of compartment syndrome.^{2,6,7,10,16-18,21,24,27}

The patient was then scheduled for surgery which was successful without complications. During the first

week after surgery, the patient received postoperative passive care consisting of compression, ice, rest, and elevation.

Postoperative chiropractic conservative management included reduction in or modification of activities and functional rehabilitation 1 week postsurgery with a continued progression for the next 5 weeks. After 5 weeks of therapeutic rehabilitation at the chiropractic clinic, the patient was able to run at a full pace without any complications or pain in the left leg.

During week 6 of rehabilitation, the patient started experiencing the initial symptoms of pain, weakness, and cramplike pain in his right leg. The right leg symptomatology prevented the patient from running more than 10 minutes. Because of the similar presentation of symptoms, the patient had right leg examined before and after exertion. During the examination of the right leg before exertion, there were again no abnormalities noted with maintained muscle strength and no pain or tenderness noted. The patient was able to perform the functional activities previously mentioned without pain or symptomatology.

An active examination was performed on the treadmill, with pain and weakness in the right tibialis anterior muscle developing after 5.12 minutes of running. The patient was instructed to discontinue activity, and the examination was reperformed. The right lower extremity became swollen from 37.0 to 45.2 cm. In addition, there were a reduction in the right lower extremity pulses and a reduction in perceived sensation on the dorsum of the right foot.

Tenderness to direct palpation along the right tibia and exacerbation of symptoms with passive dorsiflexion of the toes in dorsiflexion was also observed. The patient had full range of motion of the knee and a decrease of ankle eversion with increased pain and paresthesia over the tibialis anterior, midtibial shaft, and dorsum of the right foot. There was a decrease in muscle strength noted in the right lower extremity with a score of 2 of 5 with an increase in pain during passive great toe flexion, all compared with the well leg. All symptoms dissipated within 15 minutes after ending the treadmill test, and the above examination findings are consistent with CECS.

The patient was referred to the same orthopedic surgeon for confirmation of the diagnosis by testing compartment pressure.

Compartment test pressure monitoring was performed the same week which confirmed the diagnosis of intracompartmental pressure increase in the anterior and lateral compartments of the right leg, with a slight increase of the posterior compartment. Measurements of his compartments prior to exercise were as follows:

anterior compartment, 22 mm Hg; lateral compartment, 27 mm Hg; and posterior compartment, 10 mm Hg. Postexercise, his anterior compartment measured 77 mm Hg, the lateral compartment was 70 mm Hg, and the posterior compartment was 16 mm Hg. The patient was again scheduled for intracompartmental release/fasciotomy surgery, which successfully took place 2 days after compartment test pressure monitoring test was performed.

Following the surgery, the patient maintained a similar postsurgery rehabilitation schedule that was performed with his left leg. The patient continued to improve his stamina and speed during his running routine. He was able to increase his running time to 40 minutes without any symptoms during or after his exercise routine.

Three months after release from care, the patient reported that he was continuing with his military carrier and no symptoms or complications during basic training had manifested. Two years after initial treatment, the patient reports that he continues with regular military training, with no reoccurrence of symptoms.

Discussion

An otherwise healthy 21-year-old man who presented with a chief concern of pain in the sole of the left foot would have been a regular patient at any physician's office. The change in symptomatology and results from the functional examination were the key components that led to the diagnosis of CECS. The patient had increased training intensity and duration, which are some of the factors previously seen in patients with these types of concerns and presentation.

Exercise-induced compartment syndrome is a concern in the athletic population, with little or no response to conservative care. The presentation of leg pain with inability to continue physical activity is a red flag for inclusion of CECS in the differential diagnosis.

The exact pathophysiology is unknown as to whether CECS results from microtrauma from overtraining, ischemia from increased blood volume during exercise, or decreased elasticity within the compartments and nerve entrapment. While this debate continues, a detailed history and examination are key components toward the recognition of symptomatology and proper treatment of these patients by any evaluating physician.

In the case of CECS, the intracompartmental pressure increases from the raise in muscle size and

increased blood flow during exercise in combination with the inelasticity of the fascia surrounding each compartment, creating a vascular compromise results in ischemia.^{2,20,22,24,28,29} This ischemia is reversible with cessation of the aggravating activity. In some cases, patients will find reduction of symptoms from minutes to hours after cessation of aggravating activity. These findings are contrary to acute compartment syndrome, where the symptoms are nonremitting and the tissue damage could be permanent if not recognized. Time and duration of symptoms following activity cessation are needed, taking in consideration that irreversible tissue damage could be found in 3 hours of sustained symptomatology.^{3,9-12,30,31}

Pain and inability to continue with the intensity or duration of training are the driving forces of the patient to stop exercise or seek medical care. The diagnosis is the key element to helping the patient get the treatment necessary for the patient to return to normal activities. An aspect that has not been taken in consideration is the possibility for this condition to have a generic predisposition. In the presented case, 12 weeks postsurgery, the patient was released from care.

There is a need to continue with research in the occurrence, prevention, and postsurgical rehabilitation of exercise-induced compartment syndrome. Clinical awareness, a detailed history, and thorough examination with reproduction of symptomatology are necessary to form a proper diagnosis and treatment plan for these patients. Therefore, multidisciplinary medical communication would prove to be the most beneficial approach for the patient.

Limitations

This is a single retrospective case presentation intended to describe the case presentation and symptomatology of a patient that presented with CECS. Patient presentation and outcomes of this case may not necessarily be the same with other individuals.

Conclusion

A patient who presented with chronic leg pain received successful treatment with bilateral fasciotomy, postsurgical rehabilitation, and chiropractic care. Clinical suspicion, a detailed history, and thorough examination were the keys toward early detection and treatment.

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References

- Hislop M, Tierney P, Murray P, O'Brien M, Mahony N. Chronic exertional compartment syndrome, the controversial "fifth" compartment of the leg. *Sports Med* 2003;31:770–7.
- Hutchinson M. Chronic exertional compartment syndrome. *Sports Med* 2011;45:952–3.
- Brennan F, Kane S. Diagnosis, treatment options, and rehabilitation of chronic lower leg exertional compartment syndrome. *Curr Sports Med Rep* 2003;2:247–50.
- Barbour T, Briggs C, Bell S, Bradshaw C, Venter D, Brukner P. Histology of the fascial-periosteal interface in lower limb chronic deep posterior compartment syndrome. *Sports Med* 2004;38(6):709–17, <http://dx.doi.org/10.1136/bjism.2003.007039>.
- Cetinus E, Uzel M, Bilgic E, Karaoguz A, Herdem M. Exercise induced compartment syndrome in a professional footballer. *Sports Med* 2004;38(2):227–9, <http://dx.doi.org/10.1136/bjism.2003.004630>.
- Kowalewski K, Mayo A, Journeaux S. How a footballer got hurt without getting hit: isolated peroneal compartment syndrome of a non-traumatic cause. *Coll Surg Engl* 2007;89(8):W1–2.
- Taxter AJ, Konstantakos EK, Ames DW. Lateral compartment syndrome of the lower extremity in a recreational athlete: a case report. *Emerg Med* 2008;26(8):973.e1–2, <http://dx.doi.org/10.1016/j.ajem.2008.02.020>.
- Orlin JR, Øen J, Andersen JR. Changes in leg pain after bilateral fasciotomy to treat chronic compartment syndrome: a case series study. *J Orthop Surg Res* 2013;8:6, <http://dx.doi.org/10.1186/1749-799X-8-6>.
- Farr D, Slesnick H. Chronic exertional compartment syndrome in a collegiate soccer player, a case report and literature review. *Orthop* 2008;37(7):374–7.
- Breen DT, Foster J, Falvey E, Franklyn-Miller A. Gait retraining to alleviate the symptoms of anterior exertional lower leg pain, ac case series. *Sports Phys Ther* 2015;10(1):85–94.
- van Zoest WJ, Hoozevee AR, Scheltinga MR, Sala HA, van Mourik JB, Brink PR. Chronic deep posterior compartment syndrome of the leg in athletes: postoperative results of fasciotomy. *Sports Med* 2008;29(5):419–23 [Epub 2007 Sep 13].
- Arató E, Kürthy M, Sínay L, et al. Pathology and diagnostic options of lower limb compartment syndrome. *Clin Hemorheol Microcirc* 2009;41(1):1–8, <http://dx.doi.org/10.3233/CH-2009-1145>.
- Mallo GC, Stanat SJ, Al-Humadi M, Divaris N. Posterior thigh compartment syndrome as a result of a basketball injury. *Orthopedics* 2009;32(12):923, <http://dx.doi.org/10.3928/01477447-20091020-19>.
- Oh LS, Lewis PB, Prasarn ML, Lorch DG, Helfet DL. Painless, atraumatic, isolated lateral compartment syndrome of the leg: an unusual triad of atypical findings. *Orthop (Belle Mead NJ)* 2010;39(1):35–9.
- Burrus MT, Werner BC, Starman JS, et al. Chronic leg pain in athletes. *Sports Med* 2015;43(6):1538–47, <http://dx.doi.org/10.1177/0363546514545859> [Epub 2014 Aug 25].
- Baltopoulos P, Papadaku E, Tsironi M, Karagounis P, Prionas G. Pre, during, and post exercise anterior tibial compartment pressures in long distance runners. *J Sports Sci Med* 2008;7(1):96–100 [eCollection 2008].
- Tucker AK. Chronic exertional compartment syndrome of the leg. *Curr Rev Musculoskelet Med* 2010;3:32–7.
- Brewer RB, Gregory AJ. Chronic lower leg pain in athletes: a guide for the differential diagnosis, evaluation, and treatment. *Sports Health* 2012;4(2):121–7.
- Anuar K, Gurumoorthy P. Systemic review of the management of chronic compartment syndrome in the lower leg. *Physiother Singapore* 2006;9(1).
- Diebal AR, Gregory R, Alitz C, Gerber JP. Forefoot running improves pain and disability associated with chronic exertional compartment syndrome. *Sports Med* 2012;40(5):1060–7.
- Dahl M, Hansen P, Stål P, Edmundsson D, Magnusson S P. Stiffness and thickness of fascia do not explain chronic exertional compartment syndrome. *Clin Orthop Relat Res* 2011;469(12):3495–500, <http://dx.doi.org/10.1007/s11999-011-2073-x> [Published online 2011 September 24].
- Roscoe D, Roberts AJ, Hulse D. Intramuscular compartment pressure measurement in chronic exertional compartment syndrome: new and improved diagnostic criteria. *Sports Med* 2015;43(2):392–8, <http://dx.doi.org/10.1177/0363546514555970> [Epub 2014 Nov 18].
- Edwards PH, Wright ML, Hartman JF. A practical approach for the differential diagnosis of chronic leg pain in the athlete. *Sports Med* 2005;33(8):1241–9.
- Snowden J, Becker JA, Brosky JA, Hazle C. Chronic leg pain in a division II field hockey player: a case report. *Sports Phys Ther* 2014;9(1):125–34.
- Frink M, Hilderrbrand F, Krettek C, Brand J, Hankemeier S. Compartment syndrome of the lower leg and foot. *Clin Orthop Relat Res* 2010;468(4):940–50, <http://dx.doi.org/10.1007/s11999-009-0891-x> [Epub 2009 May 27. Review].
- Barajas BD, Sun A, Rimoin D L, Reinstein E. Recurrent compartment syndrome in a patient with clinical features of a connective tissue disorder. *Med Genet A* 2013;161(6):1442–6.
- Flaunt W, Miller J. Post-surgical rehabilitation following fasciotomies for bilateral chronic exertional compartment syndrome in a special forces soldier: a case report. *Sports Phys Ther* 2013;8(5):701–15.
- Angela MAJ, Diebal R, Gregory R, Alitz C, Gerber P. Effects of forefoot running on chronic exertional compartment syndrome; a case series. *Sports Phys Ther* 2011;6(4):312–21.
- O'hEireamhoin S, Baker JF, Neligan M. Chronic exertional compartment syndrome of the forearm in an

- elite rower. Case Rep Orthop 2011;497854, <http://dx.doi.org/10.1155/2011/497854> [Published online 2012].
30. Roar Orlin J, Øen J, Roger Andersen J. Changes in leg pain after bilateral fasciotomy to treat chronic compartment syndrome: a case series study. J Orthop Surg Res 2013;8:6, <http://dx.doi.org/10.1186/1749-799X-8-6> [Published online 2013 April 5].
31. Gallo RA, Plakke P, Silvis ML. Common leg injuries of long-distance runners: anatomical and biomechanical approach. Sports Health 2012;4(6):485–95, <http://dx.doi.org/10.1177/1941738112445871>.