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Chronic Exertional Compartment Syndrome Resolved With Running Gait Retraining: A Case Report

Abigail K. Allison, MS, ATC*; Kirsten L. Ishikawa, MS, ATC*; John Parry Gerber, PT, PhD, ATC*; Christopher Dewing, MD†

*Department of Wellness and Movement Sciences (Athletic Training Program), Eastern Washington University, Cheney; †Northwest Specialty Hospital, Post Falls, ID

A 34-year-old female athlete experienced pain, tightness, and sensation changes in her lower legs and feet when reaching approximately 1 mile (1.6 km) of her run. After a wick catheter test, an orthopaedic surgeon diagnosed her with chronic exertional compartment syndrome (CECS) and declared her eligible to undergo fasciotomy surgery. A forefoot gait is theorized to delay the symptom onset of CECS and decrease the amount of discomfort the runner experiences. The patient opted for a 6-week gait retraining program to try to alleviate her symptoms nonsurgically. The purpose of our report is to provide information about the contributing factors of CECS and to determine if gait retraining is an effective alternative to invasive surgery. After 6 weeks of gait retraining, the patient was able to run without experiencing any CECS symptoms. Also, her compartment pressures were reduced, leading the surgeon to no longer recommend fasciotomy.

Chronic exertional compartment syndrome (CECS) is a condition that causes lower leg pain and disability due to gradually increasing compartment pressure during exercise, most typically with running.[1–3] Researchers have shown this lower leg condition affects approximately 30% of runners.[4] Most patients are young recreational runners, athletes, or military recruits.[5–8]

During the subjective portion of the examination, patients with CECS of the anterior compartment, which is most common, typically report leg tightness, numbness and tingling, and general dull, achy pain after running for 10 to 15 minutes.[7] As running continues, the symptoms gradually worsen, altered running mechanics including foot drop may occur, and increased pain results in termination of the activity.[9,10] Because these symptoms typically resolve spontaneously within 15 minutes after the offending activity ends, objective examinations are frequently within normal limits. However, if the examination is conducted immediately after the offending activity, common findings include tightness of the anterior compartment, decreased dorsiflexion and toe-extensor strength, and decreased sensation of the web space between the first and second toes.

Definitive diagnosis of CECS is achieved through intracompartmental pressure measurements using a wick catheter test. Pressure measurements of >15 mm Hg at rest and >30 mm Hg postexercise in a symptomatic individual are considered positive test results for CECS.[11] In such patients, surgical intervention such as fasciotomy may be recommended to relieve the compartment pressure. Although many conservative approaches have been attempted to alleviate CECS symptoms, the evidence suggests that retraining the patient's running form may provide the most consistent, long-term positive outcomes.[9,10,12–14]

The purpose of our case study was to describe a 34-year-old female who had a 20-year history of CECS. She was offered the option of surgery, but through an uncomplicated running gait retraining program, she was able to eliminate her CECS symptoms without surgical intervention.

PATIENT

Subjective Examination

A 34-year-old CrossFit female athlete (height = 175 cm, mass = 81 kg) reported feeling a dull, achy pain and tightness in her legs and numbness and tingling in her feet when reaching approximately 1 mile (1.6 km) into every run. If she continued running, the pain and tightness would worsen until she had to stop, which was normally before reaching another mile. These symptoms were present for "as long as I can remember, even as a young teenager." She attempted to train for marathons on several occasions, gradually increasing her running time and distance, but due to leg pain and tightness, she could never run long distances continuously. When she tried to "tough through it," she said, "my legs would feel heavy, and it felt like my feet would start dragging."

Objective Examination

Observation revealed a muscular woman with no major asymmetries, deformities, or swelling. Sensation and capillary refill of the feet and toes were intact. She had normal range of motion and strength of all lower extremity joints and muscles. No pain to palpation was reported in the ankle or leg, with specific and thorough palpation conducted at the border of the medial and lateral tibial shafts and leg musculature. Ligamentous tests of the knees

and ankles were equal bilaterally. She did not have pain with the heel tap test. Because of her normal objective examination, the patient was asked to jog at a self-selected speed on a treadmill. The clinician observed the treadmill running and recorded it from a side view for additional review. The patient reported numbness and tingling in her feet after 3 minutes of running and "heavy and tight" legs after 5 minutes. In the last minutes of her run, the clinician observed the patient's foot scraping the surface of the treadmill; running was ended at 10 minutes, when it was evident she was having difficulty clearing her feet during the swing phase of her running gait. The immediate postrunning objective examination revealed tightness in her anterior leg compartments, decreased dorsiflexion and toe-extensor strength, a slight decrease in ankle-eversion strength, and slightly decreased sensation of the web space between the first and second toes. The examination findings appeared most consistent with CECS.

To confirm the diagnosis, the orthopaedic surgeon ordered a wick catheter test using a Stryker Intracompartmental Pressure Monitor (Side Port Needle). The resting pressures of the right leg were 21 mm Hg in the anterior and 15 mm Hg in the lateral compartment. The patient began running on a treadmill at a self-selected pace. At 3 minutes, she reported her first symptoms of numbness and tingling. At 6 minutes, she expressed heaviness in her legs and stated that she had to think about her foot placement. At 10 minutes, she continued to feel somewhat unsure of her steps and experienced numbness in her whole foot. The symptoms continued to worsen, and at 12 minutes, she felt uncomfortable and wanted to stop. In total, she ran for 12 minutes and completed 1.12 mile (1.8 km). After running, the pressure in her anterior compartment rose to 67 mm Hg, while the pressure in the lateral compartment showed little change at 16 mm Hg. Because of the greatly elevated compartmental pressure, the orthopaedic surgeon explained that a surgical fasciotomy would be a reasonable option to address this condition.

However, before considering surgery, the patient wanted to ensure that she had exhausted conservative approaches to her problem. One treatment approach she had not tried was modification of her running form.

INTERVENTION

Evaluation of her running form showed that the patient was a rearfoot striker with fairly long strides and a cadence of approximately 124 steps per minute (SPM). Because previous researchers[15] have demonstrated increased ground reaction forces and eccentric activity of the anterior compartment musculature of the leg with a heel-striking gait, our primary goal for this patient was to shorten her stride length and increase SPM to facilitate a forefoot-to-midfoot striking running pattern. A clinician-monitored 6-week gait retraining program was started by having her run short distances of 300–400 m unshod for 2 weeks, gradually increasing as she felt comfortable. During each running session, the patient used a metronome to assist with SPM timing. Initially, the metronome was set to 180 SPM. However, the patient felt uncomfortable with this speed, and we reduced it until she felt comfortable, settling on 160 SPM. To maintain consistency of the terrain and elevation, 90% of her training took place on a treadmill (the other 10% took place outside due to lack of availability of a treadmill). The primary guidance we provided to the patient was to focus on running smoothly and quietly during her training sessions, progress gradually, and stop running with any onset of CECS symptoms. At week 3, the patient increased her barefoot distance to 0.75 mile (1.2 km). She then transitioned back into wearing shoes and running longer distances 2 to 3 times per week. At week 4, the patient was running 3 times per week and had increased her mileage to 1.5 to 2 miles (2.4 to 3.2 km) while maintaining 160 SPM. She continued increasing time and distance, as tolerated, during weeks 5 and 6 and reported being able to run at least 3 miles without experiencing any CECS symptoms (numbness, tingling, leg pain and tightness, muscle weakness, etc).

OUTCOMES

After completing the 6-week running gait retraining, the patient repeated the wick catheter test for the anterior compartment with the same orthopaedic surgeon. However, because the lateral compartment pressure was not elevated during the first test, this measure was not repeated.

The resting pressure of the anterior compartment was 24 mm Hg. As before, the patient ran on a treadmill at a self-selected pace. She did not report any numbness, tingling, tightness or heavy legs, muscle weakness, or other symptoms that occurred during the initial testing. She ran for 24 minutes and completed 2 miles (3.2 km) before stopping. Her postrunning pressure of the anterior compartment was 45 mm Hg (Table).

DISCUSSION

This case report describes a 34-year-old female recreational athlete who, despite being symptomatic with CECS for approximately 20 years, became asymptomatic with running after a self-monitored, 6-week running gait retraining program. This outcome is consistent with the results of other studies[9,12,14] involving primarily younger male athletes who were symptomatic for approximately 1 to 2 years. In all cases, an intervention aimed at changing a heel-strike running gait to a forefoot- or midfoot-strike running gait led to relief of the pain and disability associated with CECS. Although the outcomes were similar, the type of patient (34-year-old female recreational athlete), the length of time symptomatic with CECS (approximately 20 years), and the simplicity of the intervention make this case unique.

Authors[6,8,16,17] of previous research pertaining to CECS have largely focused on surgical intervention in young adult male military recruits. The few investigators who explored changing running form as the primary intervention for CECS also studied predominantly the same population. In addition, most of these CECS patients reported symptoms lasting less than 1 year.[14] Knowing that running gait retraining can be effective for various individuals and for those who have had CECS symptoms for much longer may increase the generalizability of this intervention.

A primary goal in the running gait retraining process for a person with CECS is to increase the step cadence and shorten the stride length while running. However, currently, no consensus exists on the best interventions to retrain a person's running form. Diebal et al (2011)[16] implemented a

Table. Outcome Measures Pre- and Post-Gait Retraining Intervention for Chronic Exertional Compartment Syndrome

Pre or Post Intervention	Compartment Pressure, mm Hg		Running Distance Completed, miles (km)	Total Running Time, min	Time of First Symptom
	At Rest	Postrunning			
Pre	21	67	1.12 (1.8)	12	Min 3
Post	24	45	2 (3.2)	24	No complaint reported

protocol 3 times per week for 45 to 60 minutes that included exercises such as weight shifting, falling forward, foot tapping, high hopping, and the "EZ run belt." They also used oral cueing (eg, "run quietly"), a metronome set at 180 SPM, and video feedback to evaluate "training errors" and further assist in the running gait retraining process.[16] Helmhout et al (2015)[14] followed a similar protocol and cueing but added a team consisting of a running specialist, a physical therapist, and 2 human movement scientists who assisted with head-to-toe joint flexibility exercises, which were performed before running integration drills. In addition, they had patients run barefoot for the first 3 weeks.[14] In the current case, we tremendously simplified the gait retraining protocol. The patient started with barefoot running for 2 weeks to aid in decreasing her stride length. She used a metronome set at 160 SPM to increase the step cadence and focused on running quietly and smoothly. Although our patient was successful in relieving her symptoms after this simple running gait retraining program, more research is warranted to determine best practices in running gait retraining for patients with CECS.

One of the interesting findings in our case report consistent with similar studies were the compartment pressure readings.[14,16] Postrunning compartment pressures of approximately 70 mm Hg before running gait retraining decreased to approximately 40 to 45 mm Hg after running gait retraining. Even though the postintervention pressures were much lower than the preintervention pressures, the resultant values still categorized these patients as having CECS, even though they were all asymptomatic. According to the diagnostic criteria established by Pedowitz et al (1990),[11] intracompartmental pressure measurements of $>$15 mm Hg at rest and $>$30 mm Hg postexercise in a symptomatic individual are considered positive test results for CECS. In other words, despite consistent and substantial improvements in postexercise compartment pressure values, the values were still considered elevated. However, none of these patients met the surgical criteria because they were no longer symptomatic.

A limitation of all case report research is the lack of generalizability. This gait retraining protocol was effective for this specific 34-year-old CrossFit athlete. We cannot infer that gait retraining will be effective for others diagnosed with CECS. However, combining several case reports and case series can provide additional information to inform health care providers about best practices. A growing body of evidence shows that patients of various ages and activity levels who have symptoms of CECS for different lengths of time may benefit from running gait retraining. The approaches to retrain running gait may differ, but common threads of an effective conservative program seem to include an initial period of barefoot running practice, taking shorter and quicker strides with auditory assistance from a metronome, and focusing on running smoothly and quietly.[9,14,16]

CLINICAL BOTTOM LINE

Increasing evidence indicates that gait retraining is an effective, nonsurgical intervention for those who have CECS. Although previous researchers have demonstrated positive results in mostly young males with CECS symptoms of a relatively short duration, running gait retraining produced positive results in a 34-year-old female who had CECS symptoms for approximately 20 years. Further research is warranted in this area, yet having patients invest 6 weeks in running gait retraining before considering invasive compartment fasciotomy to treat symptoms of CECS appears to be valuable.

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Address correspondence to Abigail K. Allison, MS, ATC, Department of Wellness and Movement Sciences (Athletic Training Program), Eastern Washington University, 1106 Washington St, PE Classroom Building 200, Cheney, WA 99004. Address email to abbyallison@live.com.