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

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ABSTRACT:

A 34-year-old female athlete experienced pain, tightness, and sensation changes to her lower legs and feet when reaching approximately one mile of her run. After a wick catheter test, an orthopedic surgeon diagnosed her with chronic exertional compartment syndrome (CECS) and declared her eligible to receive a fasciotomy surgery.

It is theorized that a forefoot gait can delay symptom onset of CECS and decrease the amount of discomfort the runner experiences. The patient opted to try a 6 week gait retraining program to try to alleviate symptoms nonsurgically. The purpose of this study is to provide education of the contributing factors of CECS and to determine if gait retraining is an effective alternative to invasive surgery.

After six weeks of gait retraining, the patient was able to run without experiencing any CECS symptoms. She also had reduced compartment pressures leading the surgeon to no longer recommend her for a fasciotomy.

INTRODUCTION:

Chronic Exertional Compartment Syndrome (CECS) is a condition that causes lower leg pain and disability due to gradually increasing compartmental pressure during exercise, most typically with running [1,8,13]. Research shows this lower leg condition affects approximately 30% of runners [2]. Most patients who are affected by this condition are young recreational runners, athletes, or military recruits [6,7,17,15].

During the subjective portion of the patient 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 10 to 15 minutes [15]. As running continues, symptoms gradually worsen, altered running mechanics including foot drop may occur, and increased pain results in termination of the activity [5,18]. Because these symptoms typically resolve spontaneously within 15 minutes after the offending activity is terminated, objective examinations are frequently “within normal limits". If the patient examination is conducted immediately following the offending activity, common findings include tightness of the anterior compartment, decreased dorsiflexion and toe extensor strength, and decreased sensation over 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 greater than 15 mmHg at rest and greater than 30 mmHg post exercise in a symptomatic individual is considered a positive test for CECS [12]. In such patients, a surgical intervention such as a fasciotomy may be recommended to relieve compartmental pressure. While many conservative approaches have been attempted to alleviate CECS symptoms, evidence suggests retraining running form may provide the most consistent long-term positive outcomes [5,9,3,10,18].

The purpose of this case study is to describe a 34 year-old female who had a 20-year history of CECS. She was offered the option to have 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 (175 cm, 81 kg) reported feeling a dull, achy pain and tightness in her legs, and numbness/tingling in her feet when reaching approximately one mile into every run. If she continued running, pain and tightness would worsen until she had to stop which was normally before reaching another mile. These symptoms were present "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 performed to the border of the medial and lateral tibial shafts and leg musculature. Ligament tests of the knees and ankles were equal bilaterally. She did not have pain with a heel tap test. Because of her normal objective examination, the patient was asked to jog at a self-selected speed on a treadmill. Treadmill running was observed by the clinician and recorded from a side view for additional review. She

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 terminated at 10 minutes when it was evident she was having difficulty clearing her feet during the swing phase of her running gait. The immediate post-running objective examination revealed tightness in her anterior leg compartments, a decrease in dorsiflexion and toe extensor strength, a slight decrease in ankle eversion strength, and slightly decreased sensation of the webspace between the first and second toes. Examination findings appeared most consistent with CECS.

To confirm the diagnosis, a wick catheter test using a Stryker Intracompartmental Pressure Monitor (Side Port Needle, Kalmazoo, MI) with an orthopedic surgeon was scheduled. The resting pressure of the anterior compartment of the right leg was 21 mmHg while the resting pressure of the lateral compartment was 15mmHg. The patient then 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 reported she had to think about her foot placement. At 10 minutes she continued to feel a little unsure of her steps and had numbness in her whole foot. 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 miles. Her post-running pressure of the anterior compartment rose to 67 mmHg while the post-running pressure of the lateral compartment was little changed at 16 mmHg. Because of the greatly elevated intracompartmental pressures, the orthopedic surgeon explained that a surgical fasciotomy would be a reasonable option to consider for this condition.

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

**INTERVENTION:**

An evaluation of running form showed that the patient was a rear-foot striker with fairly long strides and a cadence of approximately 124 steps per minute (SPM). Because previous research demonstrated increased ground reaction forces and increased eccentric activity of the anterior compartment musculature of the leg with a heel-striking gait [14], the primary goal for this patient was to shorten stride length and increase SPM to facilitate a forefoot to midfoot striking running pattern while running. A clinician monitored 6-week gait retraining program was started by running short distances of 300-400 meters unshod for two weeks, gradually increasing as the patient felt comfortable. During each running session the patient incorporated the use of a metronome to assist with SPM timing. Initially the metronome was set to 180 SPM. However, the patient felt uncomfortable with this speed and the clinician reduced it until she felt comfortable, settling on 160 SPM. To maintain consistency of terrain and elevation, 90% of the patient's training took place on a treadmill (the other 10% took place outside, due to lack of availability of a treadmill). The primary guidance provided to the patient was to focus on running smoothly and quietly during her training sessions, to progress gradually, and to stop running at any onset of CECS symptoms. At week three, the patient increased her barefoot distance to ¾ of a mile. She then transitioned back into wearing shoes and running longer distances 2-3 times per week. At week four, the patient was running three times a week and had increased her mileage to 1.5-2 miles while maintaining 160 SPM. The patient continued increasing time and distance, as tolerated, during weeks five and six 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 the completion of the 6-week running gait retraining, the patient repeated the same procedure with the same orthopedic surgeon for the wick catheter test with one exception – the intracompartmental pressures of the lateral compartment were not assessed since they were not elevated during the first wick catheter test.

At this visit, the resting pressure of the anterior compartment was 24 mmHg. As before, the patient ran on a treadmill at a self-selected pace. The patient did not report any symptoms of numbness, tingling, tightness or heavy legs, muscle weakness, or any other symptom that occurred during the initial testing during the entire duration of her run. She ran for 24 minutes and completed 2 miles before stopping. Her post-running pressure of the anterior compartment was 45 mmHg (Table 1).

**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. These outcomes are consistent with other studies which consisted of primarily younger male athletes who were symptomatic for approximately 1-2 years [5,9,10]. In all cases, an intervention aimed at changing a heel-strike running gait to a forefoot-strike or midfoot-strike running gait led to relief of pain and disability associated with CECS. While the outcomes were similar, the type of patient (34 year-old female recreational athlete), the length of time being symptomatic with CECS (approximately 20 years), and the simplicity of the intervention make this case unique.

Previous research pertaining to CECS has largely focused on surgical invention of young-adult military recruits who were predominantly male [17,4,7,11]. The few articles that have explored changing running form as the primary intervention for CECS also consisted of predominantly the same population. In addition, most of these CECS patients reported symptoms lasting less than 1 year [10]. Knowing that running gait retraining can be effective for various types of individuals and for those who have had CECS symptoms for much longer may increase the generalizability of this intervention.

There appears to be consensus that a primary goal in the running gait retraining process for a person with CECS is to increase step cadence and to shorten the stride length while running. However, there is currently no consensus on the best interventions to retrain a person's running form. Diebal et al., (2011) implemented a protocol three times a week for 45 to 60 minutes that included various exercises such as weight shifting, falling forward, foot tapping, high hopping, and the "EZ run belt". They also used verbal cueing like "run quietly", a metronome set at 180 SPM, and video feedback to evaluate for "training errors" to further assist in the running gait retraining process [4]. Helmhout et al., (2015) followed a similar protocol and cueing, but added a team consisting of a running specialist, a physical therapist, and 2 human movement scientists who taught an education theory class and assisted with head-to-toe joint flexibility exercises which were performed prior to running integration drills. In addition, they had patients run barefoot for the first 3 weeks [10]. In the current case, the gait retraining protocol was simplified tremendously. The patient started with barefoot running for 2 weeks to aid in decreasing stride length. She used a metronome set at 160 SPM to increase step cadence, and she focused on running quietly and smoothly. While the patient in this case report was successful

following this simple running gait retraining program, more research is warranted to determine best practices in running gait retraining for CECS.

One of the interesting findings in our case report consistent with the other similar studies is the actual values of compartment pressure readings [4,10]. Post-running compartment pressures of approximately 70 mmHg before running gait retraining decreased to approximately 40-45 mmHg after running gait retraining. While the pressure readings were much lower compared to pre-intervention readings, the resultant values still categorized patients under a pathologic condition of CECS, even though they were all asymptomatic. According to the diagnostic criteria established by Pedowitz et al., (1990) intracompartmental pressure measurements of greater than 15 mmHg at rest and greater than 30 mmHg post exercise in a symptomatic individual is considered a positive test for CECS [12]. In other words, these studies have consistently shown substantial improvement in post-exercise compartment pressure values, albeit the values are still considered elevated. However, none of these patients met 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 for best practice. There is a growing body of evidence that patients of varying ages and activity levels, who have symptoms of CECS for varying lengths of time may benefit from running gait retraining. 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.[4,5,10]

**CLINICAL BOTTOM LINE:**

Increasing evidence is emerging that shows gait retraining is an effective, non-surgical intervention for those who have CECS. While previous research demonstrated positive results in mostly young males with CECS symptoms of a relatively short duration, this case demonstrated positive results from running gait retraining in a 34 year-old female who had CECS symptoms for approximately 20 years. While further research is warranted in this area, it appears as though there is value in having patients invest 6 weeks in running gait retraining prior to considering invasive compartment fasciotomy to treat symptoms of CECS.

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**Table 1. Outcome Measures Pre and Post Gait Retraining Intervention**

| | Compartment Pressure Measurements at rest | Compartment Pressure Measurements post running | Running Distance Completed | Total Running Time | Time of first CECS symptom |
|---|---|---|---|---|---|
| Pre Gait Retraining | 21 mmHg | 67 mmHg | 1.12 miles | 12 minutes | Minute 3 |
| Post Gait Retraining | 24 mmHg | 45 mmHg | 2 miles | 24 minutes | No complaint reported |