

Etiology of Chronic Exertional Compartment Syndrome and A Non-Surgical Treatment

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BACKGROUND

Chronic exertional compartment syndrome (CECS) occurs when increased intramuscular compartment pressure produces severe, sometimes debilitating pain and neurologic complications. Due to incomplete understanding of the pathophysiology, both diagnostic criteria and treatment options for CECS are lacking. Treatment options include various conservative treatments or fasciotomy; both of which have limitations. Studies have shown no long-term success utilizing conservative treatments.¹ Results of surgery vary, reported success rates for the anterior compartment are 86% and for the deep posterior compartment 50-65%.^{2,3} Complication rates vary between 4-13% with reoccurrence of symptoms reported in 7-17%.³ Approximately 10% of patients undergo a second revision surgery.

We propose that the underlying cause of CECS is functional venous outflow obstruction, and that image guided botulinum toxin injections effectively treat CECS by correcting this underlying cause.

METHODS

Retrospective case study of 284 patients (mean age: 27.3 ± 1.3 [95% CI], age range: 16-77, 187 female, 97 male) with exertional lower leg pain. Patients were assessed for presence and severity of CECS and areas of functional venous outflow obstruction using lower extremity MRI at rest and after exertion and CT Angiography at rest and with plantar flexion against resistance using the MVP Flex device.

Using both ultrasound and CT imaging guidance, a targeted injection of botulinum toxin was administered into the muscles at the site of venous compression.

Patients were followed up at fixed time points over several years to assess treatment response with pain logs that tracked pain on a scale of 1 to 10. Successful treatment was defined as a reduction in pain that enabled full return to activity.

RESULTS

- 90.5% ± 3.4% [95% CI] of patients displayed both CECS and functional venous obstruction.
- 86.6% ± 3.96% [95% CI] of patients were successfully treated. These patients had 78.6% ± 3.9% [95% CI] reduction in pain, and required an average of 1.98 ± 0.13 [95% CI] treatments.
- Patients that needed two treatments for successful treatment had 43.1% ± 8.5% [95% CI] reduction in pain after the first treatment.

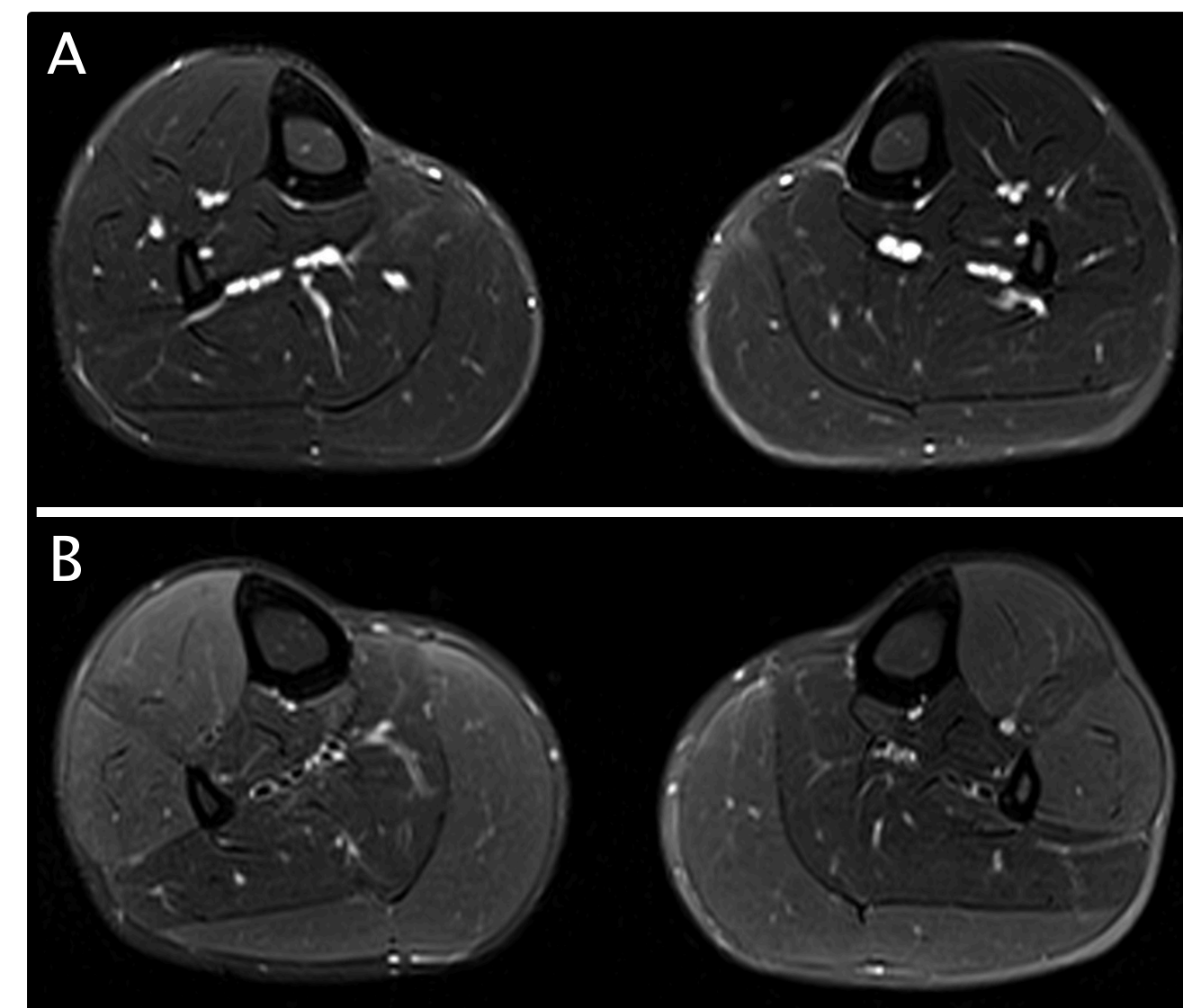
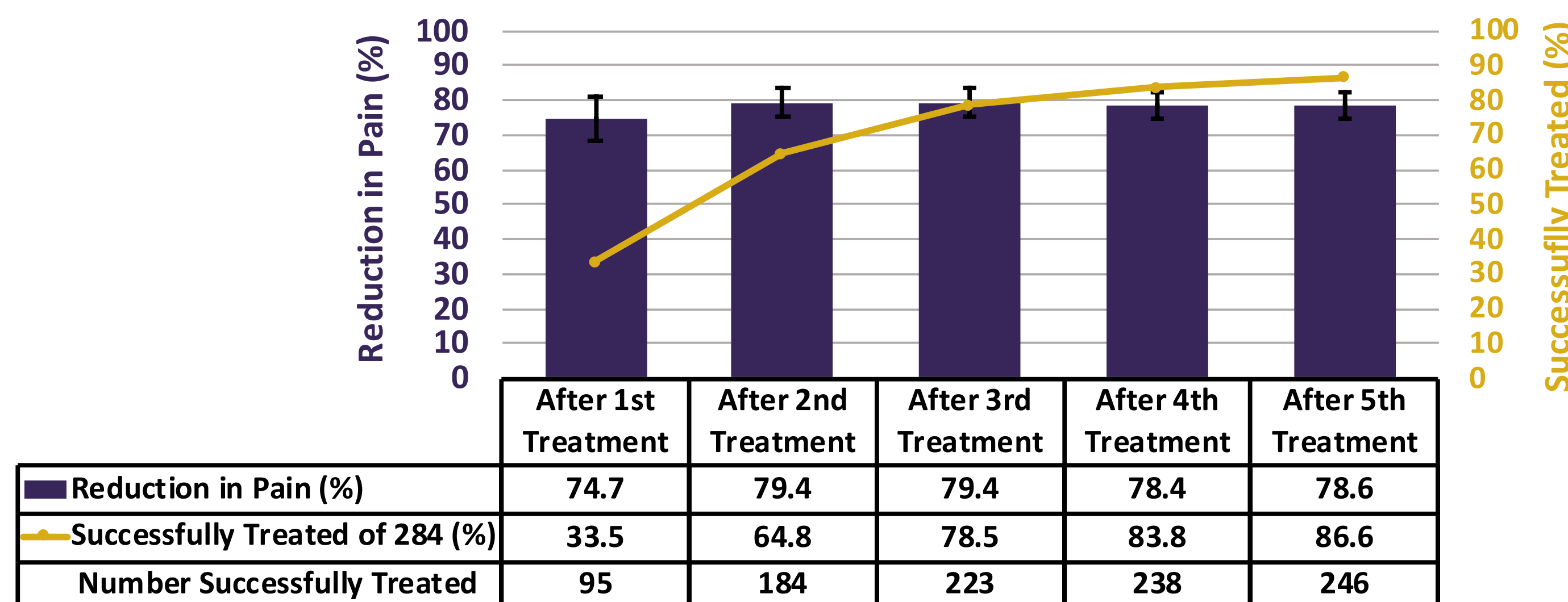
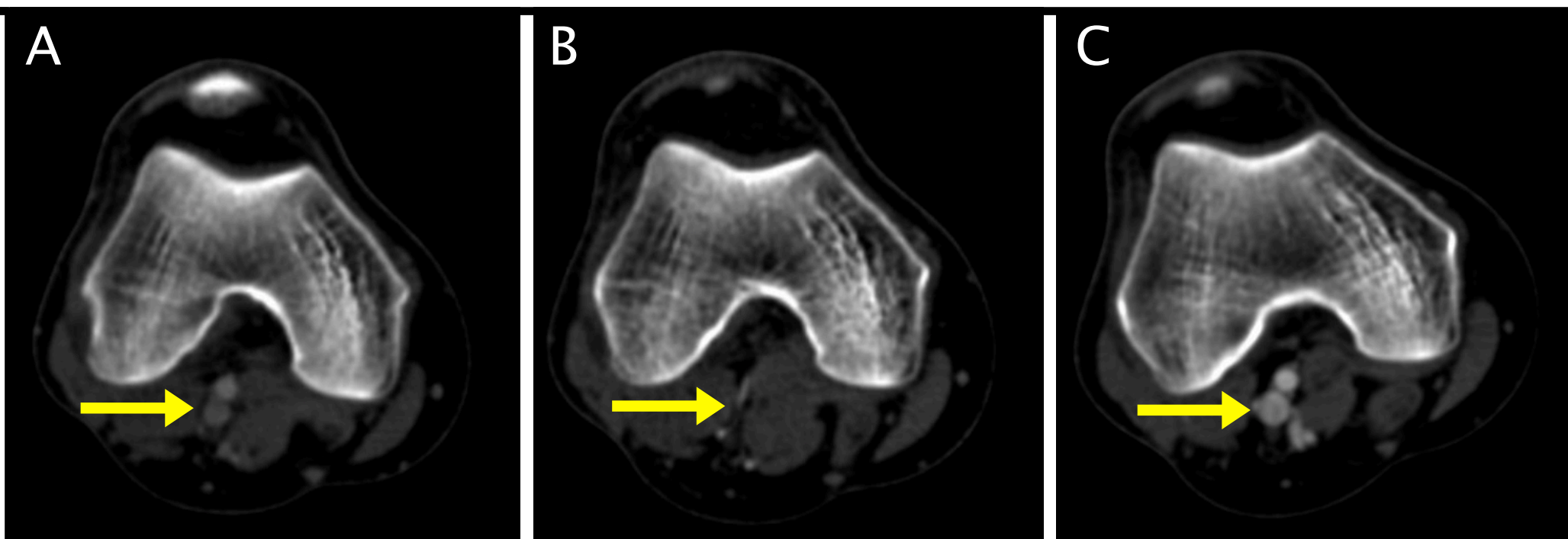


Figure 1: Pre-treatment T2 Weighted MRI to assess CECS. A: Pre-Exercise with no edema, B: Post-Exercise with edema in all four compartments

Figure 2: CTA assessing vascular entrapment.

A: Pre-treatment at rest, B: Pre-treatment during active plantar flexion, C: Post-treatment during active plantar flexion.



Plot 1: Pain Reduction in Successfully Treated Patients. Reduction in pain based percent difference of pain level prior to any treatment and the last reported pain level in successfully treated patients.

DISCUSSION

Almost all patients displayed both CECS and functional venous obstruction, therefore we believe that the primary mechanism of calf pain is functional venous outflow obstruction due to muscular compression (Fig. 2b). Arterial inflow is elevated due to exercise, yet venous outflow is obstructed. This results in elevated hydrostatic pressures and increased fluid transudation across the capillaries. This causes elevated compartment pressures and abnormal edema seen on MRI studies (Fig. 1).

Targeted botulinum toxin injections block the function of the compressing muscle, effectively relieving venous compression and restoring venous outflow (Fig. 2c). This reduced pain by 78.6% and successfully treated CECS in 86.6% of patients in this study (Plot 1).

CONCLUSIONS

The results of this study suggest CECS results from functional venous outflow obstruction due to muscular compression. This new understanding enables more effective treatment.

Targeted botulinum toxin injections at the site of venous outflow obstruction resulted in significant symptom improvement, with a short recovery period and minimal risk. This treatment provides a viable non-surgical alternative to treat CECS.

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