

Functional Outcomes After the Surgical Management of Isolated Anterolateral Leg Chronic Exertional Compartment Syndrome

Grace Gatenby,[†] MBChB, Samuel Haysom,[†] MSc, Bruce Twaddle,[†] FRACS, and Stewart Walsh,^{*†} FRACS

Investigation performed at UniSports Sports Medicine, Auckland, New Zealand

Background: Failure rates of up to 20% have been reported after fasciotomy for chronic exertional compartment syndrome (CECS). There is some evidence that postoperative failure and complication rates are higher in the posterior compartments of the lower leg than the anterolateral compartments. Isolated compartment surgery may put patients at risk of requiring revision surgery because of the risk of developing posterior compartment disease.

Hypothesis: Isolated anterolateral fasciotomy for CECS, in the absence of posterior compartment symptoms, produces satisfactory functional outcomes.

Study Design: Case series; Level of evidence, 4.

Methods: Between 2006 and 2012, patients who had positive intracompartment pressure-testing findings and who underwent isolated anterolateral fasciotomy release for CECS were given a self-administered questionnaire. The minimum follow-up was 3 years. The questionnaire addressed time to return to sport and ongoing symptoms. A visual analog scale was used to assess pain during exercise before and after surgery (score: 0, no pain; 10, worst pain imaginable); overall satisfaction with the procedure was assessed as well. Of 31 eligible patients, 20 patients (36 legs operated on) were assessed.

Results: Postoperatively, 90% of participants returned to the same or higher level of sport. The mean pain score during exercise before surgery was 8.17, whereas it was 1.74 after surgery. The overall mean patient satisfaction score was 8.64. Only 1 leg (2.8%) went on to develop posterior compartment syndrome.

Conclusion: Isolated anterolateral fasciotomy for CECS produced excellent functional outcomes. Our rate of recurrence was low compared with those found in the literature, and 90% of participants returned to their same or higher level of sport postoperatively.

Keywords: chronic exertional compartment syndrome; compartment pressure; fasciotomy; compartment release

Chronic exertional compartment syndrome (CECS) is a well-recognized cause of lower leg pain, seen typically in young and athletic patients.^{5,7,12,15,17,20,23} The exact pathophysiology of CECS is unknown; however, the prevailing theory describes an exercise-induced increase in blood flow and resultant increased volume and pressure within the compartments of the lower leg, leading to ischemic pain.^{2,7,10,13,21,23} The resultant symptoms and signs

therefore depend on the anatomic contents within each compartment^{7,13,23} and the compliance of the fascial envelope.

Patients typically present with recurrent and reproducible tightness, pain, numbness, paresthesia, and a sense of “incoordination” at a specific point of exertion, which resolves completely after a period of inactivity.^{2,12,17} Clinical examination findings are usually normal, until after provocation of the affected compartment with repetitive loading.^{3-5,7,14,20} This will uncover tenderness to palpation of the affected compartment, pain with passive stretching of the compartment, and firmness of the involved compartment, which may be associated with muscle herniation.²³

CECS may occur in any of the fascial compartments of the leg. It commonly affects the anterior compartment^{1,2,19}; this may present as anterolateral pain and tightness, numbness or paresthesia over the dorsum of the foot/in between the first and second toes, weakness of dorsiflexion or eversion, or incoordination.^{3,4,7,9,20,23} While this diagnosis can be made by clinical history and physical examinations,^{12,17,20} the diagnosis is made more precise by

*Address correspondence to Stewart Walsh, FRACS, UniSports Sports Medicine, 71 Merton Rd, St Johns, Auckland 1743, New Zealand (email: s.walsh@extra.co.nz).

[†]UniSports Sports Medicine, Auckland, New Zealand.

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intracompartmental pressure testing. The Pedowitz criteria¹³ are the most widely accepted standards of measurement for pressure testing,^{1,12,19,23,25} although other criteria have been described.^{6,18}

The nonoperative treatment of CECS has been shown to be largely ineffective unless the patient significantly reduces his or her activity level as a means of management.^{9,10} The most effective and only definitive treatment currently is fasciotomy, and there have been several different techniques described in the literature.^{9-11,16} Evidence from previous studies suggests that the anterior and lateral compartments have better outcomes after fasciotomy compared with the deep posterior compartment.^{1,15,17,19,20,23,25} Isolated release can be shown to result in a possible reduced rate of complications, minimized scarring, and a quicker return to sport than the rates seen in patients who undergo deep posterior compartment release.^{10,19} The risk of isolated release is that patients may go on to develop deep posterior compartment syndrome and require another surgical procedure.

Several studies have reported good results with isolated anterior and lateral compartment release. In 2005, Stein and Sennett²² reported “excellent outcomes” and patient satisfaction when only the anterior and lateral compartments were released endoscopically. In 1999, Schepsis et al¹⁹ reported satisfactory outcomes in 87% of patients undergoing anterolateral release.

This study aimed to build on the available literature through the demonstration of functional outcomes and patient satisfaction after isolated release of the anterolateral leg compartments, in the absence of deep posterior compartment symptoms.

METHODS

A retrospective case series study was conducted of active patients diagnosed with isolated anterolateral compartment syndrome who underwent surgical release between 2006 and 2012. All patients who underwent isolated anterolateral fasciotomy were identified from 2 surgeons' files at a single clinic in Auckland, New Zealand, and were sent a self-administered questionnaire for each leg operated on to evaluate their functional outcomes after surgery and their overall satisfaction with the procedure. Their clinical and surgical notes were also reviewed. Follow-up data collection was carried out from 2015 to 2016.

Patients were eligible for inclusion if they had clinical signs and symptoms of isolated anterolateral CECS, had no symptoms or signs of deep posterior compartment disease, had positive intracompartmental pressure test findings (according to the Pedowitz criteria¹³), and underwent anterolateral fasciotomy with the surgical technique described below. Most patients only underwent pressure testing of their anterior and lateral compartments. The patients who did have deep posterior compartment pressure measured were found to have normal pressure in this compartment. Patients diagnosed with additional abnormalities, such as nerve entrapment, were excluded from the study. Pressure testing was carried out using a Stryker

Pressure Monitor System with a side port needle, following repetitive ankle dorsiflexion until the point where symptoms were severe.

The minimum follow-up period was 3 years. Letters were sent containing a self-administered questionnaire to all patients. The questionnaire was designed for this study and used a 10-cm visual analog scale (VAS; 0 = no pain; 10 = worst pain imaginable) to assess patients' pain before and after surgery at rest and during exercise as well as their overall satisfaction with the procedure. Best efforts were made to contact patients and reduce the effect of loss to follow-up. Six patients could not be contacted, and 5 patients declined to participate.

A total of 31 patients had undergone anterolateral compartment release between 2006 and 2012. Of these, 20 patients replied to the self-administered questionnaire, giving a response rate of 64.5%, a small sample size, and a total of 36 legs operated on that could be assessed for complications and functional outcomes.

Surgical Technique and Postoperative Management

Surgery was performed through two 4-cm incisions made longitudinally over the anterolateral aspect of the leg, with a 10-cm bridge of skin between them. Through the distal incision, the superficial peroneal nerve was identified and protected. The skin bridge was then mobilized between the 2 incisions. Under direct vision, fasciotomy was performed using scissors on the anterior and lateral compartments, taking care to protect the superficial peroneal nerve. The fascia was widely split. More proximally in the compartment, some of the muscle fibers arose from the fascia, and these were mobilized so that the fascia would spread. If required, this technique was replicated on the contralateral limb. The wounds were packed and the tourniquet deflated. Hemostasis was then achieved. The wounds were then closed over a drain, and local anesthetic was injected around the surgical areas before the dressings were applied.

All operative procedures were carried out by 1 of 2 orthopaedic surgeons (B.T., S.W.) experienced in the technique. Postoperatively, patients were admitted to the hospital overnight, and their legs were kept elevated. They received 2 postoperative doses of antibiotics. Drains were removed the next morning, and patients were discharged on crutches. Follow-up occurred approximately 7 days postoperatively, and the patients began cycling at 10 to 14 days. At 6 weeks, patients were able to commence a graduated running program.

RESULTS

The mean age of the 20 participants assessed in this patient survey was 27.5 years. Eight patients were male, and 12 were female. The mean length of time with symptoms before surgery was 31.6 months. Patient demographics can be found in Table 1. Two of the 20 patients (10%) were unable to return to sport after surgery. The remaining 18 patients (90%) returned to sport at the same or higher level

TABLE 1
Patient Demographics

Age, mean (range), y	27.5 (16-50)
Sex, n	
Male	8
Female	12
Ethnicity, n	
New Zealand European	18
Maori	1
Indian	1
Length of symptoms before surgery, mean (range), mo	31.6 (1-131)
Main symptoms, n	
Pain only	10
Tightness only	0
Both pain and tightness	10
Neurological symptoms, n	5
Incoordination symptoms, n	3
Bilateral symptoms, n	16
Unilateral symptoms, n	4
Level of sport before surgery, n	
National representative	2
Regional representative	4
Competitive	4
Recreational	10

TABLE 2
Postoperative Outcomes^a

Returned to sport after surgery (n = 20 patients), n (%)	
Yes	18 (90)
No	2 (10)
Level of sport returned to (n = 18 patients), n	
Same	10
Higher	8
Pain score during exercise before surgery (0-10 on VAS), mean ± SD	8.17 ± 1.85
Pain score during exercise after surgery (0-10 on VAS), mean ± SD	1.74 ± 2.56
Patient satisfaction score (0-10), mean ± SD	8.64 ± 2.01
Ongoing symptoms postoperatively (n = 36 legs), n (%)	
Pain	14 (39)
Numbness	19 (53)
Tingling	16 (44)
Muscle weakness	6 (17)
Herniation	7 (19)
None	11 (31)
Recurrence of anterolateral CECS (n = 36 legs), n (%)	1 (2.8)
Development of posterior CECS (n = 36 legs), n (%)	1 (2.8)
Major complications (n = 36 legs), n (%)	3 (8.3)

^aCECS, chronic exertional compartment syndrome; VAS, visual analog scale.

than they had previously achieved. The mean patient satisfaction score was 8.64. The mean pain score during exercise before surgery was 8.17, and the mean pain score during exercise after surgery was 1.74.

There was minimal recurrence among the study participants. One leg required further surgery for revision of anterior compartment release and deep posterior compartment release. Another patient developed symptoms of posterior compartment disease but had negative pressure testing findings; this patient was managed with nonoperative treatment and a graduated running program and returned to his/her previous level of sport. In this study, there was only 1 leg that developed posterior compartment syndrome, resulting in the need for further surgery; thus, the rate of legs developing posterior compartment syndrome after isolated release was 2.8%.

There were 7 complications postoperatively (19.4%). One patient developed deep vein thrombosis, 1 patient developed a recurrence of anterior compartment syndrome during the follow-up period, and another developed deep posterior compartment syndrome. The other 4 complications were scar related and were judged to be minor; 2 legs had superficial reactions to the sutures, which resolved, and 1 patient requested scar revision on both legs. All results can be seen in Table 2.

DISCUSSION

The key findings of this study are that isolated fasciotomy resulted in a reduction in pain during exercise. Ninety percent of participants were able to return to their previous level of sport or higher. Additionally, only 1 leg went on to be diagnosed with deep posterior CECS.

One limitation of isolated anterolateral compartment release is the possibility of developing CECS in the posterior compartment. However, in this study, this was only observed in 1 leg (2.8%). With regard to this low rate, it is important to note that all patients in this series had no signs or symptoms of posterior disease. The percentage of patients requiring revision fasciotomy after release of all lower leg compartments has been reported in the literature to be as high as 20%.^{21,24} This shows that requiring revision surgery is a relatively common outcome after release. By comparison, in this study, only 1 leg required revision anterolateral surgery. Therefore, it may not be necessary to release all compartments on all patients with CECS. The outcomes show that there may not be any benefit from operating on the posterior compartment in the absence of disease, and in fact, this may cause harm.

Only 1 leg in the study required revision surgery for the anterolateral compartments operated on, giving a surgical recurrence rate of 2.8%. Again, this recurrence rate is much lower than the rates of up to 20% reported elsewhere in the literature for release of all compartments in the leg.^{21,24} No study has defined preoperative factors that predispose a patient to fasciotomy failure, although it has been suggested by Packer et al¹² that age younger than 23 years and isolated anterior compartment release are associated with improved patient satisfaction and subjective function postoperatively.

Release of all compartments is a bigger procedure. It is thought to be associated potentially with an increased risk of complications and increased scarring and is possibly more likely to result in adverse outcomes. Complication rates in the literature have been reported to be between 11% and 13%.^{1,7,12,25} The rate for major complications in this study was found to be 8.3%; therefore, this series

produced a similar complication rate to that reported in the literature for all-compartment fasciotomy.

Success rates postoperatively for fasciotomy in CECS have been reported in the literature as low as 50%.¹⁶ There is much variation, and most studies reported outcomes that are generally favorable, ranging between 71% and 100%.^{1,8,17,20,25} We achieved excellent outcomes in this study. Only 2 participants (10%) were unable to return to their previous level of sport; the remaining 90% successfully had a full return to activity. All participants in the current series were athletes, and this may have resulted in an increased motivation to return to sport, thereby contributing to a high rate of return to activity. Additionally, 40% of participants returned to sport at a higher level than they had previously achieved. Only 1 study participant reported being dissatisfied with the surgical outcome.

There is much variation reported in the literature about postoperative return to sport. In 2013, Waterman et al²⁴ presented the surgical outcomes of fasciotomy for CECS in a military population. Of 611 patients, 27.7% were unable to return to full activity. By comparison, we found that only 10% of participants were unable to return to sport. In 2006, Mouhsine et al¹¹ studied 18 athletes who underwent fasciotomy using the 2-incision technique that was also used in the current study; these authors reported that all patients were able to return to their previous level of sport. They reported no complications or revision surgery. Clearly, there is much variation in postoperative outcomes for CECS; this may relate at least partly to how little is known about the pathophysiology of the disease as well as the preoperative factors that may predispose patients to unsatisfactory outcomes.

Of the participants, 69% still experienced some symptoms postoperatively, including pain, numbness, tightness, weakness, or muscle herniation. The most frequent report was of numbness over the surgical site, which is a common outcome. Participants reported that these postoperative symptoms were not impairing function, especially when compared with the preoperative pain/tightness that they had suffered. The mean pain score during exercise was reduced from 8.17 of 10 before surgery to 1.74 of 10 after surgery. The mean patient satisfaction score was 8.64 of 10, representing a high functional outcome for almost all study participants. Between this high satisfaction rating and the fact that all but 2 patients returned to their previous or higher level of sport, this study has demonstrated the possibility of high functional outcomes in patients undergoing isolated anterolateral release, without a corresponding increase in the need for revision surgery, as is often feared with this surgical technique.

This study is inherently limited by its retrospective design. The minimum follow-up period of 3 years allowed us to capture the recurrence and symptoms experienced by most patients within our data set, therefore making our results more complete. However, this meant that some patients returned for follow-up 9 years after their procedure, introducing the possibility of recall bias. Additionally, the follow-up was limited by the fact that patients were not physically examined and did not undergo repeat pressure testing. Our study was also limited by the small cohort size

and the response rate of 64.5%, leading to the possibility of attrition bias. Part of the reason for this response rate may be attributable to the transient living circumstances of younger patients and patients in urban areas. Response rates have been a problem in many studies on CECS fasciotomy outcomes; for example, a large 2013 study on functional outcomes by Packer et al¹² had a reported response rate of 41%.

The strengths of this study are a well-described surgical method, with all participants operated on by 1 of 2 surgeons experienced in the technique. All participants underwent preoperative pressure testing, with positive results according to the Pedowitz criteria,¹³ minimizing the likelihood of an incorrect diagnosis. Last, the researchers had access to all operative and follow-up notes, allowing for detailed knowledge of anything that may have influenced outcomes.

CONCLUSION

We present a small retrospective case series study of functional outcomes for patients with CECS with isolated anterolateral disease who underwent careful clinical assessments and standardized compartmental pressure testing. In patients diagnosed with isolated anterolateral CECS, isolated release resulted in a rate of 90% returning to sport, a marked improvement in symptoms, an 8.3% rate of major complications, and a common outcome of ongoing minor symptoms. Only 1 leg went on to be diagnosed with posterior compartment disease. Based on these results, we recommend isolated anterolateral release for patients without symptoms of posterior compartment disease.

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