Case Report

Patient-Reported Outcomes Following Fasciotomy for Chronic Exertional Compartment Syndrome

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Abstract: Background. *Lower extremity chronic exertional compartment syndrome (CECS) can negatively affect exercise and activity and may require operative intervention to release the fascia. Few studies have evaluated or compared patient-reported outcomes for bilateral versus single-leg staged fasciotomy and number of compartments released.* Methods. *A total of 27 eligible patients who underwent a fasciotomy procedure for CECS at a single institution were identified. A retrospective review of the medical record was performed, and individuals were contacted by phone to collect patient-reported outcomes, including ability to return to desired exercise level, postoperative expectation assessment, European Quality of Life—Five Dimensions, and the Foot and Ankle Ability Measure sports subscale.* Results. *A total of 21 patients were available for follow-up (average follow-up 36.9 months). The average single numeric assessment evaluation of lower-extremity function in sport was 87.5% in those who underwent a simultaneous bilateral fasciotomy (n = 10), 94% in those who had a staged unilateral fasciotomy (n = 5), and 74% in those who underwent an isolated single-leg fasciotomy. In all, 91% (n = 10) of patients who had all 4 compartments released intra-operatively were able to return to their desired exercise level versus 66.7% (n = 6) of those who did not have all 4 compartments released.* Conclusion. *The patient-reported outcomes of a staged unilateral fasciotomy and simultaneous bilateral fasciotomy for CECS are similar. Those who did not have all 4 compartments released reported worse outcomes. Further research should be conducted on the short-term outcomes and cost-effectiveness of a bilateral versus staged fasciotomy procedure.*

Levels of Evidence: *Level IV: Case series*

Keywords: chronic exertional compartment syndrome; patient-reported outcomes; fasciotomy; sports medicine

Introduction

Chronic exertional compartment syndrome (CECS) is a condition resulting from increased pressure within one or several of the 4 muscle compartments of the lower leg (anterior, lateral, posterior superficial, and posterior deep).[1] CECS is typically brought on by repetitive activity of the lower limb and is most common among athletes and soldiers who perform strenuous physical activities on a regular basis. Intracompartmental

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manometry of the 4 compartments of the lower leg is currently the gold standard for diagnosis.[2,3]

CECS often occurs simultaneously in both legs, and limited literature exists on the efficacy of simultaneous bilateral fasciotomies versus staged unilateral procedures. A retrospective case series comparing outcomes of bilateral versus staged fasciotomy reported a return to function an average of 12 weeks earlier for patients who underwent bilateral fasciotomy versus a staged single-leg fasciotomy, with adequate patient-reported outcomes in both cohorts.[4] Researchers concluded that a simultaneous bilateral fasciotomy can be safely and effectively performed. In addition to clinical benefits, reducing the need for a second operative intervention may decrease the cost for both the patient and the health care system. However, few studies have evaluated the long-term outcomes of individuals undergoing bilateral versus staged fasciotomies. Additional research is needed to assess the operative outcomes of 4-compartment release versus 2-compartment release. Previous literature analyzing outcomes of 4 compartment release versus anterior and lateral release only reported a 3.5-week delay in return to sport for the 4-compartment release cohort.[5] Further analysis on functional outcomes and patient satisfaction for bilateral and staged fasciotomies, as well as number of compartments released, is warranted to better inform clinicians on long-term outcomes and operative considerations.

The purpose of this study was to present patient-reported outcomes recorded during intermediate follow-up with a cohort of patients undergoing a fasciotomy for CECS. The 2 main goals of the study were to (1) evaluate patient-reported outcomes for the number of compartments released intraoperatively and (2) evaluate patient-reported outcomes for a bilateral versus single-leg staged fasciotomy for CECS.

Methods

After approval by the institutional review board, a billing search of CPT codes (27600, 27601, 27602) was performed for the senior authors at our institution from 2005 to 2016 to identify patients who underwent a fasciotomy procedure for CECS. A total of 4 surgeons were included in the study. The surgical technique was performed with the patient supine, and anatomical landmarks were identified on the skin. A distal lateral incision was made approximately 10 cm proximal to the distal end of the fibula centered between the tibial crest and fibula and extended proximally. The superficial peroneal nerve was identified and protected. The fascia of both the anterior and lateral compartments was identified and fasciotomies were performed both proximally and distally in each compartment while protecting the superficial peroneal nerve. In some cases, a small incision 10 cm proximal to the distal incision was made to ensure that complete releases were performed as far proximally as necessary. For the release of the superficial and deep posterior compartments, a 5- to 6-cm incision was made 1 to 2 cm posterior to the medial tibial border. Care was taken to protect the neurovascular structures, including the saphenous nerve and vein in the superficial compartment and the posterior tibial artery, vein, and nerve in the deep compartment. Following all releases, care was taken to ensure that there was adequate hemostasis before skin closure. Postoperatively, all patients were sent home with crutches and allowed to weight bear as tolerated. At the 2-week postoperative visit, all patients were allowed to slowly increase activity as tolerated under the guidance of the physician and a physical therapist. Inclusion criteria were one or more fasciotomies performed with the intent-to-treat CECS, with a minimum follow-up of 2 years from the date of surgery. Exclusion criteria were a fasciotomy performed in the setting of trauma, age less than 18 years at the time of follow-up, and concomitant surgery or unrelated lower-leg pathology at the time of follow-up. A total of 27 patients met the inclusion criteria.

Patient demographics and clinical data, including preoperative examination, diagnostic testing, operative details, complications, and subsequent surgery, were recorded via a retrospective review of the medical record. Patients who met the inclusion criteria were mailed a letter detailing the aims of study, followed up with a phone call giving further details and asking for verbal consent to participate in the voluntary survey study; if consenting, the survey was administered. Study data were collected and managed using REDCap (Research Electronic Data Capture) electronic data capture tools hosted by Partners HealthCare Research Computing Enterprise Research Infrastructure & Services (ERIS) group. REDCap is a secure, web-based application designed to support data capture for research studies.[6]

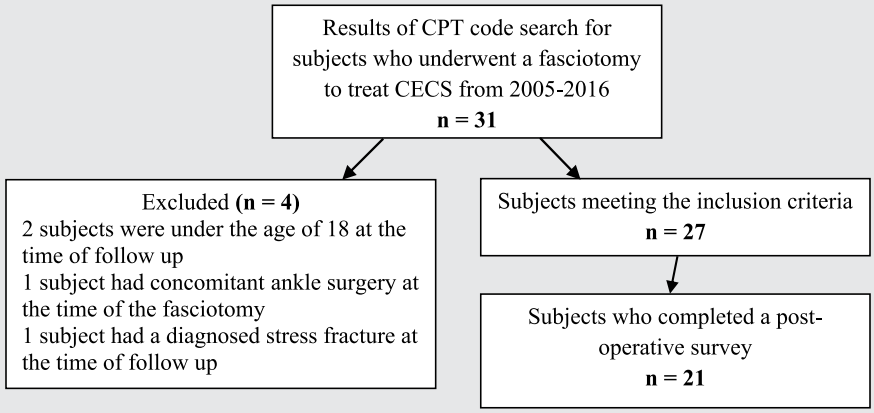
Participants were asked to report the type of sport or activity they participated in and at what level (professional, collegiate, high school, recreational) prior to the onset of symptoms. They were then asked to report if they were able to return to the desired level of exercise following surgery. Participants completed a standard postoperative expectations form to report how the surgery met expectations on a 3-level response (did not meet, met, or exceeded expectations) with regard to 5 items: reduction of pain, improvement of strength and motion in the affected extremity, resuming normal functions for daily living, and resuming normal sporting activities. The European Quality of Life—Five Dimensions (EQ-5D) was used to assess overall quality of life, and the sports subscale of the Foot and Ankle Ability Measure (FAAM) was used evaluate higher functioning sport abilities.[7,8] As part of the FAAM sports subscale, a Single Assessment Numeric Evaluation (SANE) was used to assess current level of function during sports activities in comparison with level of function during sports activities prior to injury.[8]

Statistical Analysis

A descriptive analysis of demographics such as sex, age, body mass index (BMI),

Figure 1.

Flowchart of included and excluded patients in the study cohort.



Abbreviations: CPT, Current Procedural Terminology; CECS, chronic exertional compartment syndrome.

duration of symptoms, and average time to follow-up was performed. The standard postoperative expectations form was divided into a binary classification of "did not meet expectations" versus "met or exceeded expectations." The EQ-5D is scored on a scale of 0 to 1.0, with 1.0 indicating optimal quality of life. The 8-item FAAM sports subscale is scored on a scale of 4 to 0, with 4 being "no difficulty" in performing activity and 0 being "unable to do." The highest potential score is 32. The item score is divided by the highest potential score and multiplied by 100 to represent the level of the percentage of physical function.[8] The SANE portion of the FAAM sports subscale was scored as 0% to 100%, with 100 indicating the level of function prior to injury, and 0 indicating inability to perform any usual daily activites.[8]

Results

A total of 31 patients underwent fasciotomy for the treatment of CECS between 2005 to 2016. Of the 31 patients, 27 met the inclusion criteria and 21 were available for follow-up at an average of 213 months (range = 32-329 months) after surgery (response rate 77.7%). Six patients were not available for follow-up despite numerous attempts.

Table 1.

Demographics of the Overall Cohort.

Characteristic	Frequency, n (%) [N = 21]
Male	5 (23.8)
Female	16 (76.2)
Age (years)	24.68 (8.26)
Body mass index	26.82 (5.59)
Duration of symptoms (months)	15.0 (8.9)
Average time between staged operations (n = 5) (months)	18 (range = 3-48)

Four patients were excluded for the following reasons: 2 patients were younger than 18 years, 1 patient had concomitant ankle surgery at the time of compartment releases, and 1 patient had a tibial stress fracture at the time of follow-up (Figure 1). Of the 21 patients analyzed in this study (Table 1), 76.2% were female (n = 16); the mean age was 24.7 years (SD ± 8.26), and the average BMI was 26.8 kg/m^2 (SD ± 5.59). Patients reported experiencing symptoms for an average of 15.0 months prior to fasciotomy. The patients were analyzed according to the operative procedure. A total of 10 patients underwent a simultaneous bilateral fasciotomy during which the surgeon released both lower limbs during the same surgery; 5 patients underwent planned staged operations—2 separate procedures performed on each limb at different times by the same surgeon. Six patients underwent unilateral fasciotomy during which the surgeon released the affected compartments in a single limb. Of the 6 patients who underwent a unilateral fasciotomy, one required a subsequent contralateral fasciotomy because of new onset of symptoms in the contralateral

limb (Figure 2). For patients who underwent staged fasciotomies (n = 5), an average of 18 months (range = 3-48) elapsed between surgeries.

Table 2 compares outcome measures across the 4 different operative groups (bilateral 1 surgery; bilateral staged; single leg; single-leg staged). The staged fasciotomy cohort had the highest average satisfaction, with 100% of the patients reporting that the procedure met or exceeded their preoperative expectations (Table 2). The staged fasciotomy cohort reported an average EQ-5D score of 1.0, an average FAAM score of 90%, and an average SANE score of 94%. No patient experienced complications after undergoing a staged fasciotomy.

Within the bilateral fasciotomy cohort, 70% of the patients reported that the procedure met/exceeded their preoperative expectations, and 90% reported that it met/exceeded their preoperative expectations with regard to pain reduction (Table 2). Of 9 patients, 7 (78%) reported ability to return to their desired sport activity level. This cohort reported an average EQ-5D score of 0.948, an average FAAM of 84.4%, and an average SANE of 87.5% (Table 2). Complications for the bilateral fasciotomy procedure were minimal, with 2 patients developing a hematoma that needed evacuation.

Within the single-leg operation cohort, 60% of the patients reported that the procedure met/exceeded their preoperative expectations (Table 2). The single-leg operation cohort also reported an average EQ-5D score of 0.903, an average FAAM score of 80%, and an average SANE score of 74% (Table 2). No patient experienced complications from a single-leg fasciotomy.

There was 1 patient who underwent a second surgery for new symptoms in the contralateral leg, and this patient reported that the procedure 100% met/exceeded preoperative expectations in all categories (Table 2).

Table 3 compares outcome measures for patients who underwent a 4-compartment release versus 2-compartment release. Among patients who underwent a 4-compartment release (n = 12), 91% were able to return to the desired sport activity level. Eleven of the 12 patients (91.7%) in the 4-compartment release cohort reported that the procedure met/exceeded expectations with regard to pain reduction and strength/motion improvement, and 75% reported that the procedure met/exceeded expectations with regard to return to sport. The 4-compartment release cohort reported an average EQ-5D score of 0.944 (SD ± 0.082), an average FAAM score of 89.1%, and an average SANE score of 89.2%. Within the 2-compartment release cohort, 78% of the patients reported that the procedure met/exceeded expectations with regard to pain reduction, strength/motion improvement, and return to sport. Of 9 patients who underwent 2-compartment release, 6 (67%) reported being able to return to the desired sport activity level, and this cohort reported an average EQ-5D score of 0.963 (SD ± 0.073), an average FAAM score of 84.0%, and an average SANE score of 82.7%.

Discussion

This analysis reveals that, in general, patients in all operative groups (bilateral, staged, single leg, and single leg with subsequent contralateral fasciotomy) report high satisfaction with the outcome of fasciotomy. These results are consistent with previous research performed by Campano et al,[9] who report an 84% satisfaction rate with patients who underwent a fasciotomy to treat CECS. Review of the current literature demonstrates a lack of standardized outcome measurements following a fasciotomy to treat CECS. Our assessment of outcomes, similar to that of Pasic et al,[3] contacted a retrospective cohort of patients via telephone to administer questionnaires. The questionnaires included determinations for return to sport and patient satisfaction as well as the 20-item Lower Extremity Functional Scale, in contrast to our study, which utilized EQ-5D, FAAM, and SANE scores to assess outcomes.[3]

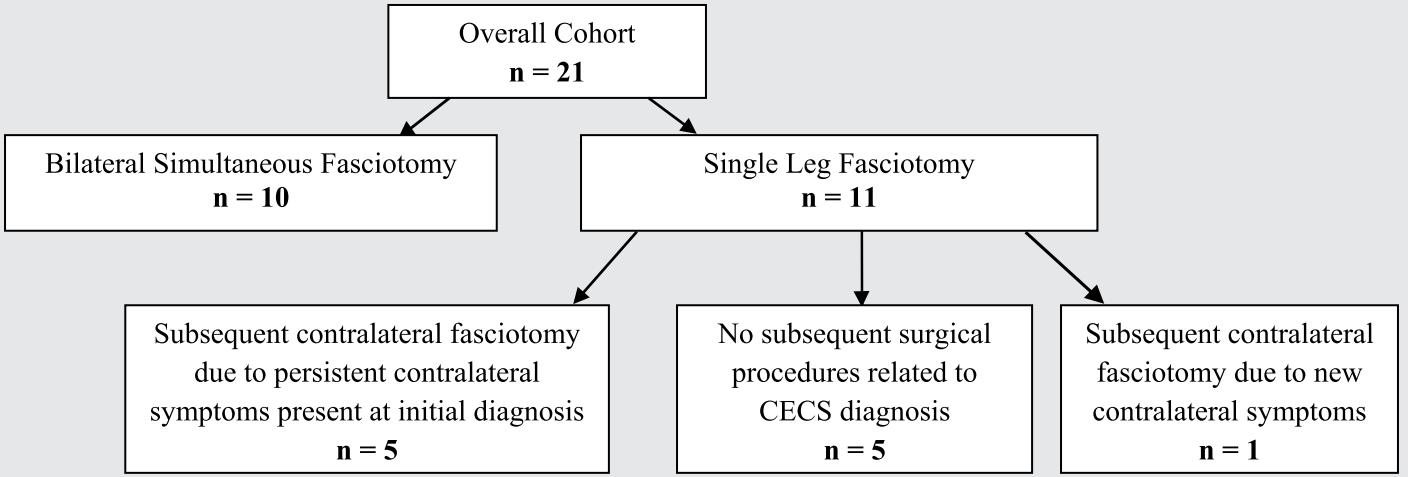
When comparing the outcomes of staged versus bilateral fasciotomy, patients who underwent a staged fasciotomy reported that the procedure met/exceeded expectations at a higher rate than patients who underwent a bilateral fasciotomy. The staged fasciotomy cohort also reported a higher EQ-5D, FAAM, and SANE score than the bilateral fasciotomy cohort. However, when considering a bilateral versus staged operation, surgeons and patients need to weigh the potential for complication versus the length of recovery time. In this study, the average length of time between staged procedures was 19 months. It is important to note that not all staged procedures were planned; rather, the patients experienced a significant increase in symptoms in the contralateral leg following the initial operation that caused them to seek a contralateral fasciotomy. Raikin et al[4] reported an average recovery period of 23 weeks for staged fasciotomy versus 11 for bilateral fasciotomy. In addition, bilateral fasciotomy may also decrease health care costs by reducing the need for a second operative intervention.

Our results also demonstrate that patients who underwent single-leg fasciotomies were the least satisfied with the outcome of the procedure. A potential reason for this includes the presence of compartment syndrome in the contralateral limb, which was undiagnosed prior to surgery. Because CECS occurs bilaterally in 70% to 80% of the population, surgeons should consider intracompartmental pressure (ICP) testing on the contralateral limb. It has been suggested that those with increased manometry readings on the asymptomatic side may consider a bilateral release.[1]

When comparing the outcomes of 4-compartment release versus 2-compartment release, patients who underwent 4-compartment fasciotomies reported higher satisfaction and return to function than patients who underwent 2-compartment fasciotomies.

Figure 2.

Surgical procedures performed.



Abbreviation: CECS, chronic exertional compartment syndrome.

Table 2.

Results of Patient-Reported Outcome Measures for Patients Treated With a Simultaneous Bilateral Fasciotomy, Staged Bilateral Fasciotomy, Unilateral Fasciotomy, or a Contralateral Fasciotomy for New Symptoms.[a].

Patient-Reported Outcome Measure	Bilateral Simultaneous Fasciotomies (n = 10)	Staged Bilateral Operation (n = 5)	Single Unilateral Operation (n = 5)	Contralateral Fasciotomy for New Symptoms (n = 1)
Felt they were able to return to desired sport activity level	7 (77.8%)[b]	5 (100%)	3 (60%)	1 (100%)
Standard postoperative expectation assessment				
Pain reduction[c]	9 (90%)	5 (100%)	3 (60%)	1 (100%)
Improvement in strength and motion[c]	7 (70%)	4 (80%)	3 (60%)	1 (100%)
Return to functions for daily living[c]	7 (70%)	5 (100%)	4 (80%)	1 (100%)
Return to sport activities[c]	7 (70%)	5 (100%)	3 (60%)	1 (100%)
EQ-5D	0.948	1.0	0.903	1.0
FAAM sports subscale	84.37%	90.0%	80%	100%
Single Assessment Numeric Evaluation for sports function	87.5%	94%	74%	100%

Abbreviations: EQ-5D, European Quality of Life—Five Dimensions; FAAM, Foot and Ankle Ability Measure.
[a]All values are presented as n (%) or mean (SD) unless otherwise indicated.
[b]One patient did not participate in sports.
[c]Percentage of patients for whom the procedure met or exceeded postoperative expectations.

Table 3.

Patient-Reported Outcome Measures for Patients Who Had All 4 Compartments Released Intraoperatively Versus Patients Who Had Less Than 4 Compartments Released.[a]

Patient-Reported Outcome Measure	Four-Compartment Release (n = 12)	Partial Compartment Release (<4; n = 9)
Felt that they were able to return to desired sport activity level	10 (91%)[b]	6 (66.7%)
Standard postoperative expectation assessment		
Pain reduction[c]	11 (91.7%)	7 (77.8%)
Improvement in strength and motion[c]	11 (91.7%)	7 (77.8%)
Return to functions for daily living[c]	12 (100%)	8 (88.9%)
Return to sport activities[c]	9 (75%)	7 (77.8%)
EQ-5D	0.944 (0.082)	0.963 (0.073)
FAAM sports subscale score	89.1%	84.0%
Single Assessment Numeric Evaluation in sports function	89.2%	82.7%

Abbreviations: EQ-5D, European Quality of Life—Five Dimensions; FAAM, Foot and Ankle Ability Measure.
[a]All values are presented as n (%) or mean (SD) unless otherwise indicated.
[b]One patient did not participate in sport activities.
[c]Percentage of patients for whom the procedure met or exceeded postoperative expectations.

Limitations

There are several limitations to this study. First, there is inherent bias in a retrospective case series—specifically, recall and attrition bias. Additionally, an a priori sample size calculation was not performed. There were 6 individuals who met the inclusion criteria of the study who were lost to follow-up despite numerous attempts to establish contact. The collected data are based on long-term outcomes (average of 213 months after surgery) and, therefore, do not assess short-term postoperative complication rates or short-term patient satisfaction. Second, the sample size is small, making it difficult to determine statistically significant differences between operative groups. Therefore, our study lacks the ability to draw a precise conclusion as to which technique offers superior operative outcomes.

Conclusion

This analysis of patient-reported outcomes reveals that both bilateral and staged fasciotomies are effective treatments for CECS. Patients who did not have all 4 compartments released reported worse outcomes. A possible explanation for worse outcomes in the 2-compartment release cohort includes development of CECS postoperatively in the compartments not released, indicating that surgeons may consider a 4-compartment release even if manometry reveals elevated pressures only in select compartments. Further research on short-term prospective outcomes for staged and bilateral fasciotomies, as well as for 4-compartment release and partial compartment release, is needed to assess which operative procedure offers the lowest complication rates with greatest return of function.

Declaration of Conflicting Interests

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Ethical Approval

Not applicable.

Informed Consent

Not applicable.

Trial Registration

Not applicable.

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