

Minimally Invasive Treatment of Chronic Exertional Compartment Syndrome: A Case Series

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ABSTRACT

Introduction: Chronic exertional compartment syndrome causes exertion-induced limb pain. It predominantly affects young athletes and the diagnosis is confirmed by measuring intracompartmental pressure. Fasciotomy is the treatment of choice when symptoms do not respond to conservative management. Minimally invasive decompression has gained increasing attention because of its lower morbidity and faster patient recovery. **Objective:** To describe the surgical technique and its clinical, functional, and patient-reported outcomes. **Materials and Methods:** A retrospective descriptive study was conducted on three men with chronic exertional compartment syndrome who underwent surgery between 2021 and 2025. The following variables were analyzed: demographic characteristics, pain assessed using the Visual Analog Scale (VAS), function assessed using PROMIS®, quality of life assessed using the EuroQol-5D, sports activity level assessed using the Tegner Activity Scale, complications, and patient satisfaction. **Results:** The median age was 27 years. Pain decreased from 10 to 2. The PROMIS® T-score increased from 49.0 to 55.0, and the EuroQol-5D score increased from 0.85 to 1.0. Two patients exceeded their preinjury sports activity level, and one returned to the same level. One minor complication was recorded. **Conclusions:** Minimally invasive fasciotomy achieved satisfactory preliminary clinical and functional outcomes; however, larger comparative studies are needed to validate these findings. **Keywords:** Chronic exertional compartment syndrome; fasciotomy; minimally invasive surgery; leg pain.

Level of Evidence: IV

Tratamiento mínimamente invasivo para el síndrome compartimental crónico por ejercicio: serie de casos

RESUMEN

Introducción: El síndrome compartimental crónico por ejercicio causa dolor en las extremidades inducido por el esfuerzo. Afecta predominantemente a atletas jóvenes y su diagnóstico se confirma midiendo la presión intracompartmental. La fasciotomía es la técnica de elección cuando el cuadro no responde al manejo conservador. La descompresión mínimamente invasiva ha ganado relevancia, debido a la menor morbilidad y la rápida recuperación del paciente. **Objetivo:** Describir la técnica quirúrgica y los resultados clínicos, funcionales y subjetivos. **Materiales y Métodos:** Estudio descriptivo retrospectivo de 3 hombres con síndrome compartimental crónico por ejercicio operados entre 2021 y 2025. Se analizaron las siguientes variables: demográficas, dolor (escala analógica visual), función (PROMIS®), calidad de vida (EuroQol-5D), nivel deportivo (clasificación de Tegner), complicaciones y satisfacción. **Resultados:** La mediana de edad fue de 27 años. El dolor disminuyó de 10 a 2. El puntaje T aumentó de 49,0 a 55,0 y el puntaje del EuroQol-5D, de 0,85 a 1,0. Dos pacientes superaron su nivel deportivo previo y uno lo igualó. Se registró una complicación menor. **Conclusiones:** La fasciotomía mínimamente invasiva logró resultados clínicos y funcionales preliminares satisfactorios; sin embargo, se requieren estudios comparativos más amplios para validar estos hallazgos.

Palabras clave: Síndrome compartimental crónico por ejercicio; fasciotomía; cirugía mínimamente invasiva; dolor de pierna.

Nivel de Evidencia: IV

INTRODUCTION

Chronic exertional compartment syndrome (CECS) is a condition characterized by pain caused by increased intracompartmental pressure (ICP) within fascial compartments. It occurs primarily in individuals who engage in intense physical activity and can affect both the lower and upper extremities.¹ The classic symptoms include

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pain, muscle tightness, weakness, cramps, and paresthesias, which are relieved by cessation of exercise and rest.^{2,3} However, diagnosis remains challenging because of the nonspecific and variable clinical presentation. It is established based on clinical findings and the measurement of ICP before and after exercise, which is considered the gold standard.⁴

CECS predominantly affects young athletes, particularly runners and soccer players (more commonly involving the lower extremities), as well as weightlifters and motorcyclists (more commonly involving the upper extremities).¹ According to military studies, Velasco et al.³ reported an annual incidence of approximately 1 case per 2,000 individuals. The exact etiology remains unknown, although factors such as repetitive microtrauma, myopathies, vascular compromise, decreased fascial compliance, and muscle hypertrophy have been proposed.⁵

Conservative treatment includes physical therapy, massage therapy, nonsteroidal anti-inflammatory drugs, and foot orthoses.¹ However, fasciotomy is currently the surgical treatment of choice for refractory cases.² Available techniques include traditional open, endoscopic, and minimally invasive fasciotomy.¹ Minimally invasive fasciotomy has shown encouraging results, with return to activity at approximately three weeks and high patient satisfaction rates,⁶⁻⁸ although some authors have reported potentially higher rates of complications or recurrence.⁹

To mitigate the risks of blind dissection and incomplete decompression commonly associated with single-incision techniques,^{8,10} we adopted a dual-incision approach.¹¹ This method allows direct visualization and protection of the superficial peroneal nerve, thereby ensuring adequate fascial release.¹¹

The objective of this study was to evaluate whether this dual-incision approach combines the safety of the open technique with the accelerated functional recovery associated with minimally invasive surgery. We describe a minimally invasive fascial decompression technique used in three patients with CECS and evaluate the clinical and functional outcomes, patient satisfaction, and return to sports activity.

MATERIALS AND METHODS

A descriptive, retrospective, observational study was conducted in three patients diagnosed with CECS who underwent minimally invasive fascial decompression between 2021 and 2025. The diagnosis was established based on clinical evaluation, imaging studies, and post-exercise ICP measurements according to the criteria proposed by Pedowitz et al.⁴ All patients had symptoms refractory to conservative treatment and were therefore indicated for surgical management.

Conservative treatment consisted of a nonoperative approach aimed at correcting extrinsic and intrinsic factors potentially associated with the development of the condition. All patients completed a physical therapy program focused on stretching and muscle-strengthening exercises, together with a gradual reduction in training volume and modifications to the training surface and athletic footwear. In addition, they used custom foot orthoses to improve alignment and reduce repetitive impact forces on the affected compartments.¹² Conservative treatment was maintained for a minimum of six months before surgery was indicated because of persistent symptoms and functional impairment.

Patients older than 16 years with confirmed CECS, established by clinical examination and ICP measurement, who underwent minimally invasive surgery and had a minimum follow-up of six months were included. Patients with acute compartment syndrome, concomitant musculoskeletal disorders, or incomplete medical records were excluded.

Surgical Technique

The patient is placed in the supine position under spinal anesthesia with a thigh tourniquet. A minimally invasive dual-incision technique is used for decompression of the anterior and lateral compartments.¹¹ Two longitudinal incisions approximately 2.5-4 cm in length are made along the lateral aspect of the leg. The proximal incision is located approximately three fingerbreadths distal to the fibular head, whereas the distal incision is placed three fingerbreadths proximal to the lateral malleolus. Both incisions are centered over the intermuscular septum, identified using the leg compression test.⁷ It is essential to identify and protect the superficial peroneal nerve before performing the distal fasciotomy. Its course should be identified during the preoperative physical examination, as the nerve typically emerges through the deep fascia at the junction of the middle and distal thirds of the leg.⁸

The fasciotomy is performed in a minimally invasive manner using Metzenbaum scissors. The fascia is identified, and adequate release is confirmed both visually and by digital palpation. At least 90% of the total fascial length should be released to prevent recurrence due to incomplete decompression.⁵ For the posterior compartments (superficial and deep posterior compartments), a single longitudinal incision approximately 5 cm in length is made 2.5 cm medial to the tibial crest at the mid-leg level.¹¹ The great saphenous vein and saphenous nerve are identified and protected. Before wound closure, the tourniquet is released and meticulous hemostasis is achieved. The procedure is performed unilaterally or bilaterally, depending on the case. An elastic compression bandage is applied, and weight-bearing as tolerated with crutch assistance is allowed immediately after surgery. The surgical technique is shown in the [Figure](#).



Figure. Surgical technique.

The analyzed variables were obtained from the medical records, postoperative follow-up, and a structured telephone survey. All patients provided written informed consent. Demographic, clinical, imaging, and functional data were collected. The recorded variables included age, sex, affected side, comorbidities, type of sport practiced, preoperative and postoperative functional level according to the Tegner Activity Scale,¹³ clinical characteristics (symptoms, time from symptom onset to surgery expressed in months, time to pain onset during sports activity expressed in minutes, and preoperative and postoperative visual analog scale [VAS] scores),¹⁴ preoperative imaging studies (pre- and post-exercise magnetic resonance imaging, ultrasonography, and plain radiographs), post-exercise ICP measurements in the anterior, lateral, and posterior compartments of both legs, postoperative complications, return to work and sports activity measured in weeks, and qualitative return-to-sport level based on the patient's perception.

ICP was measured using a multiparameter monitor connected to a mean arterial pressure measurement system through a three-way stopcock. The system was flushed with saline solution, and a 14-gauge Abbocath catheter was used for pressure measurements. After calibration and zeroing, the transducer was positioned at the same level as the lower extremities, and measurements were obtained from the different compartments. To ensure reproducibility and minimize interobserver variability, all measurements were performed by the same senior surgeon. The provocation protocol consisted of continuous running until the patient reported symptom limitation. Measurements were obtained immediately after cessation of exercise, always within 5 minutes of symptom reproduction.

All postoperative complications were recorded and classified throughout follow-up, including infections, neurological injuries, seromas, hematomas, symptom recurrence, and the need for reoperation.

Return to activity was evaluated by recording the time elapsed, in weeks, from surgery to resumption of sports participation, as well as the level achieved compared with the preoperative level, according to the patient's perception, and categorized as: same level, lower level, higher level, change of sport, or no return.

Patient satisfaction was assessed using a structured telephone survey based on a five-point Likert scale.¹⁵ Patients were classified as very satisfied if they reported no or mild pain and no difficulty walking; satisfied if they reported mild pain, walking with or without slight difficulty, and willingness to undergo the same procedure again under similar circumstances; neither satisfied nor dissatisfied if they expressed no clear opinion; dissatisfied if they reported moderate pain, difficulty walking, and doubts regarding the success of the procedure; and very dissatisfied if they experienced greater pain and greater difficulty walking than before surgery. In addition, patients were asked: "*Knowing the outcome now, would you choose to undergo the same surgery again?*", with a dichotomous (Yes/No) response.

The Spanish version of the PROMIS® Physical Function Short Form 10a (PROMIS® PF-10a)^{16,17} was used as a standardized instrument for assessing self-reported physical function. This questionnaire consists of 10 items developed using item response theory and measures functional capacity in adults across activities ranging from basic daily tasks to more demanding physical activities. The Spanish version has been validated, ensuring conceptual and linguistic equivalence. PROMIS® PF-10a provides a precise, efficient, and responsive assessment with high reliability. Results are expressed as T-scores (mean = 50; standard deviation = 10), allowing direct comparison with the general population and across different clinical groups. The instrument evaluates the patient's ability to perform activities ranging from dressing and personal hygiene to running and lifting weights. Each item is scored from 1 to 5, with higher scores indicating better physical function. Raw scores range from 10 to 50 and are subsequently converted into T-scores. Values above 60 indicate excellent physical function or absence of limitations; values around 50 ± 10 represent average function in the general population; and values below 40 indicate significant functional impairment. An increase of ≥ 4 –6 T-score points is considered a clinically meaningful improvement in physical function.

Health-related quality of life was assessed using the EuroQol-5D (EQ-5D) questionnaire,¹⁸ which allows patients to rate their health status across five dimensions: mobility, self-care, usual activities, pain/discomfort, and anxiety/depression. Each dimension is classified into three severity levels (no problems, some problems, or severe problems), generating a five-digit profile that describes the individual's health status. These profiles are converted into a utility index based on population preference values, ranging from 1 (best possible health state) to 0 (equivalent to death), with negative values possible for health states considered worse than death. For this study, the Spanish social value set proposed by Herdman et al. (2001)¹⁸ was used, assigning specific coefficients to each dimension and severity level.

Statistical Analysis

The results are presented descriptively using measures of central tendency (mean and median) and dispersion (standard deviation and interquartile range [IQR]), together with absolute and relative frequencies, owing to the small sample size.

RESULTS

Three male patients were included, with a median age of 27 years (IQR 22-28). Two had bilateral involvement and one had unilateral right-sided involvement. Two were active smokers. All three participated in sports: one played competitive field hockey (Tegner level 8), one played competitive padel (level 6), and the third participated in recreational soccer combined with weight training (level 6). The median follow-up was 25.3 months (IQR 7-55.6).

The median time from symptom onset to surgery was 18 months (IQR 12-72), and the median time from the start of exercise to pain onset was 5 minutes (IQR 3-10).

Intracompartmental pressure measurements were obtained after exercise, within 5 minutes of symptom onset, and all values were elevated, consistent with CECS. In Patient 1, pressures were 35 mmHg in the anterior compartment, 39 mmHg in the lateral compartment, and 42 mmHg in the posterior compartment of the right leg, and 32, 41, and 40 mmHg, respectively, in the left leg. In Patient 2, pressures were 38 mmHg in the anterior compartment and 40 mmHg in the lateral compartment of the right leg, and 36 and 37 mmHg, respectively, in the corresponding compartments of the left leg, confirming bilateral chronic involvement. Patient 3 had pressures of 42 mmHg in the lateral compartment and 30 mmHg in the posterior compartment of the right leg, and 19 and 13 mmHg, respectively, in the corresponding compartments of the left leg. These values exceeded the commonly accepted diagnostic thresholds, defined as pressures >30 mmHg immediately after exercise or >20 mmHg at 5 minutes, according to the criteria proposed by Pedowitz et al.⁴ The ICP measurements are summarized in Table 1.

Table 1. Measurement of intracompartmental pressure.

Measurement of intracompartmental pressure (mmHg)	Right leg			Left leg		
	Anterior	Lateral	Posterior	Anterior	Lateral	Posterior
Patient 1	35	39	42	32	41	40
Patient 2	38	40		36	37	
Patient 3		42	30		19	13

All patients underwent imaging studies that showed no structural abnormalities. Two patients underwent post-exercise magnetic resonance imaging, which revealed no muscle edema, fascial hernias, or signs of neurovascular entrapment.

The median time to return to work was 3 weeks (IQR 1-6), whereas return to sports occurred after a median of 8 weeks (IQR 4-32). Two patients returned to a higher level of sports participation than before surgery, and one returned to the same level. None changed sports or discontinued athletic activity.

The Tegner Activity Scale remained unchanged, with a median score of 6 (IQR 6-8) both preoperatively and postoperatively. In contrast, pain measured with the visual analog scale (VAS) decreased substantially, from a median of 10 (IQR 8-10) preoperatively to 2 (IQR 0-4) after surgery.

The PROMIS® PF-10a T-score increased from a median of 49.0 (IQR 47.0-49.4) to 55.0 (IQR 49.4-61.0), reflecting an overall improvement in physical function. Similarly, the EuroQol-5D index increased from 0.85 (IQR 0.85-1.0) to 1.0 (IQR 1.0-1.0), indicating improved postoperative health-related quality of life.

Only one patient experienced minor complications: a superficial hematoma that resolved with compressive bandaging and mild dysesthesia at the lateral incision site of the left leg, which improved during follow-up. The dysesthesia resolved spontaneously without permanent motor or sensory sequelae. No infections, symptomatic recurrences, or reoperations were recorded.

In the satisfaction survey, two patients reported being very satisfied and one reported being neither satisfied nor dissatisfied. Two patients answered “Yes” to the question, “*Would you choose to undergo the same surgery again?*” The remaining patient answered “No,” stating that the postoperative recovery period had been prolonged and demanding. The clinical and demographic characteristics of the patients are summarized in [Table 2](#).

Table 2. Clinical and demographic characteristics of the patients.

Variables	
Patients	3
Age, median (IQR)	27 (22-28)
Male sex	3
Side	
Right	1
Left	0
Bilateral	2
Comorbidities	
Smoking	2
Sports played	
Field hockey	1
Padel	1
Soccer	1
Time from symptom onset to surgery (months), median (IQR)	18 (12-72)
Time to symptom onset during exercise (min), median (IQR)	5 (3-10)
Return to work (weeks), median (IQR)	3 (1-6)
Return to sports (weeks), mean (SD)	8 (4-32)
Level of return to sports	
Better level	2
Same level	1
Lower level	0
Changed sports	0
Did not return	0
Tegner classification, median (IQR)	
Preoperative	6 (6-8)
Postoperative	6 (6-8)
Would you undergo the surgery again?	
Yes	2
No	1
Likert satisfaction level	
Very satisfied	2
Satisfied	0
Neither satisfied nor dissatisfied	1
Dissatisfied	0
Very dissatisfied	0
Visual Analog Scale for pain, median (IQR)	
Preoperative score	10 (8-10)
Postoperative score	2 (0-4)
T score, PROMIS® PF-10a, median (IQR)	
Preoperative	49.0 (47.0-49.4)
Postoperative	55.0 (49.4-61.0)
EuroQoL-5D Index, median (IQR)	
Preoperative	0.85 (0,85-1.0)
Postoperative	1.0 (1,0-1.0)
Follow-up (months), median (IQR)	25.29 (7-55.59)

IQR = interquartile range.

DISCUSSION

In this series of three patients who underwent minimally invasive fascial decompression, overall clinical and functional improvement was observed, with a marked reduction in pain, full return to sports participation, and high levels of patient satisfaction. Only one minor complication was recorded: a superficial hematoma and transient dysesthesia that resolved spontaneously. These findings are consistent with those reported in the literature, which demonstrates satisfactory functional recovery, low morbidity, and rapid return to sports following minimally invasive techniques.^{1,5}

The main contribution of this study is the use of a dual-window approach to overcome the limitations of single-incision techniques, as it allows direct visualization of the superficial peroneal nerve while ensuring complete fascial release. This modification successfully combines the safety of the traditional open approach with the advantages of accelerated functional recovery associated with minimally invasive surgery.

Broderick et al.⁸ described a minimally invasive technique assisted by an illuminated retractor that allows fascial release under direct visualization through a single 3-4 cm lateral incision. They highlighted the ability to visualize the superficial peroneal nerve and avoid blind dissection as a major advantage. All five patients in their series returned to sports at 12 weeks without complications, yielding results comparable to those observed in our study. Oliver et al.⁷ reported the use of the mini-open lower limb fasciotomy (MLLF) technique in a cohort of 38 patients. They found a complication rate of 16% and a reoperation rate of 8%. Pain improved significantly, 64% of patients returned to sports, and overall satisfaction reached 74%, although a considerable proportion experienced partial recurrence of symptoms.

Similarly, Thein et al.¹⁹ compared conservative treatment with minimally invasive anterior compartment fasciotomy in 43 patients and observed significantly greater improvements in pain and Tegner Activity Scale scores in the surgical group, with 77.4% of patients returning to their preinjury level of sports participation compared with 25% in the conservatively treated group. These findings support the role of surgical treatment in refractory cases, particularly among young athletes with high functional demands.

Grechenig et al.²⁰ evaluated the safety of minimally invasive fasciotomy of the anterior, lateral, and deep posterior compartments in 60 cadaveric lower extremities. Complete fascial release was achieved in 97%-100% of specimens without significant neurovascular injury, confirming the anatomical feasibility and safety of the technique. Nevertheless, in the literature, the overall complication rate of minimally invasive techniques is approximately 13%.⁵ In this regard, the minor complication observed in our series (a superficial hematoma associated with transient dysesthesia that resolved spontaneously) is consistent with published reports. Likewise, Maffulli et al.²¹ evaluated 18 athletes treated through a single minimal incision and reported that 94% returned to their previous or a higher level of sports participation, together with significant improvements in SF-36 and EQ-5D scores, without major complications or recurrences.

Baumfeld et al.²² published a prospective series of 13 patients with chronic exertional compartment syndrome treated using a minimally invasive technique and reported a significant improvement in Tegner scores (from 3.9 to 7.1; $p = 0.01$), enhanced athletic performance, an increase in weekly running distance from 14 to 38 km, and 92% of patients reporting satisfaction or high satisfaction after a minimum follow-up of 12 months. These findings provide contemporary evidence that minimally invasive fasciotomy improves athletic performance and quality of life while maintaining a low complication rate, in agreement with our results.

More recently, endoscopic and ultrasound-guided techniques have also been described, offering the theoretical advantages of less soft-tissue trauma and improved cosmetic outcomes. However, their use remains limited by technical complexity, the risk of iatrogenic injury, and the lack of robust comparative evidence.^{23,24}

Overall, the available evidence supports minimally invasive fasciotomy as a safe and effective alternative to the open approach, providing equivalent functional outcomes while reducing morbidity and improving cosmetic recovery. The minimally invasive technique shortens incision length, preserves soft tissues, and facilitates earlier rehabilitation, although an adequate learning curve is required to ensure complete fascial release.²⁰

The diagnosis of CECS remains challenging because its symptoms may mimic medial tibial stress syndrome, nerve entrapment syndromes, or exertional claudication.^{12,25,26} Post-exercise ICP measurement remains the diagnostic gold standard, although its availability is limited.^{4,27} Post-exercise magnetic resonance imaging may provide complementary information, particularly in atypical cases or when findings are inconclusive.²⁸⁻³⁰ Clinical suspicion therefore remains essential to avoid delayed diagnosis and treatment.

Regarding functional assessment, no disease-specific scales or return-to-sport criteria have been developed for patients with CECS. Consequently, validated instruments such as the PROMIS® PF-10a and EuroQol-5D were used to objectively quantify physical function and health-related quality of life.¹⁶⁻¹⁸ Although these instruments were not specifically designed for CECS, they provide a standardized framework that facilitates interinstitutional comparisons and longitudinal follow-up.

The limitations of this study include its small sample size, retrospective design, and the selection bias inherent to this type of analysis. Nevertheless, CECS is a rare and frequently underdiagnosed condition, making even small case series valuable for describing the application and outcomes of emerging surgical techniques. A methodological strength of this study is that all procedures were performed by the same surgeon, thereby reducing technical variability.

In summary, our findings demonstrate a favorable trend regarding symptom relief, return to sports participation, and postoperative satisfaction following minimally invasive fascial decompression. However, prospective multicenter studies with larger cohorts and longer follow-up are required to confirm its effectiveness and establish definitive comparisons with conventional approaches.

CONCLUSIONS

Minimally invasive fasciotomy for the treatment of chronic exertional compartment syndrome yielded satisfactory preliminary clinical and functional outcomes, including substantial pain relief, early return to sports, high patient satisfaction, and minimal postoperative morbidity. Although these findings suggest that this technique represents a viable therapeutic option for young, active patients, the descriptive nature of the study and the small sample size require that the results be interpreted as preliminary. Larger multicenter studies with longer follow-up are needed to definitively establish its benefits.

Conflicts of interest: The authors declare no conflicts of interest.

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