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ORIGINAL ARTICLE

Return to activity following fasciotomy for chronic exertional compartment syndrome

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Abstract Diagnosis of chronic exertional compartment syndrome (CECS) is relatively rare but has been well documented in athletes. There are, however, few reports regarding return to athletic activity after surgery among elite-level athletes. We hypothesized that a majority of elite-level athletes would successfully return to their previous level of competition following fasciotomy for CECS. A retrospective chart review was performed to identify elite-level athletes (collegiate or professional sport participation) who underwent fasciotomy for CECS over a 3-year period. Data collected included sport or activity, treatment and surgical details, time away from sport/activity after surgery, and ability to return to prior level of activity. Six males and seven females were included in the analysis. Patient age ranged from 17 to 24 years with a mean of 19.7 years. Six patients underwent unilateral lower extremity compartment release, and seven underwent bilateral lower extremity compartment release. The anterior and lateral compartments alone were released in 11 patients (84.6 %). Two patients (15.4 %) underwent four-compartment releases. Eleven patients (84.6 %) were able to return to their previous elite level of sport participation at a mean of 10.6 weeks following surgical fasciotomy. Patients who had four-compartment release had a more than 3.5 week average longer return to full sporting activities ($p = 0.011$). Fasciotomy is effective in allowing elite athletes with CECS to return to sport.

Keywords Compartment syndrome · Fasciotomy · Compartment release · Return to sport

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Introduction

The diagnosis of chronic exertional compartment syndrome (CECS) is uncommon. However, it is a frequent problem and part of an extensive differential diagnosis in the running athlete with leg pain. It can be seen in recreational and competitive athletes alike, with an incidence ranging from 27 to 33 % of exercise-related leg pain, second only to medial tibial stress syndrome [4, 9, 21]. Typically, patients present with symptoms after increased intensity and duration of workouts that abate with cessation of activity. The leg is the most frequent anatomical site for CECS, particularly in running athletes [2]. Over time, the pain that is experienced during exercise may increase, and patients may experience greater limitations during running activities. Since no symptoms occur at rest, the ailment can frequently go undiagnosed for a period of time increasing the severity of the condition [9, 23]. While CECS is a clinical diagnosis, objective measurements of the intracompartmental pressure in a patient may help to confirm the diagnosis [24].

Once the diagnosis is made, treatment can be nonoperative, including rest, removal from inciting activity, stretching, anti-inflammatories, correction of training errors, and orthotics. If the patient fails to respond in a 3 to 6-month period or if nonsurgical treatment is not feasible

or desired, surgical fasciotomy may be indicated. This procedure effectively releases the pressure on the compartment and is considered the most successful and definitive treatment [3, 11, 23]. As with all surgical interventions, complications may result [1]. Because the injury affects mostly athletes, many patients choose to undergo surgery because they do not wish to change their lifestyle or be removed from physical activity [3]. Satisfactory results have been produced in more than 80 % of patients [12, 17], with significant reduction in symptoms having been reported in previous studies [6, 12, 17, 22].

Of concern for an athlete undergoing fasciotomy is the ability to return to the same level of activity as prior to the onset of symptoms. Several studies have reported on successful return to sports by athletes [5, 7, 14, 18, 24, 26] or more specifically return to previous levels of participation following fasciotomy [20]. While several of these reports show successful return to sport in the recreational athlete, to our knowledge, there are no studies reporting on a group of elite-level (college and/or professional) athletes. There are several case reports involving elite athletes [8, 10, 13, 16], but no studies exist reporting on the outcomes of a group of elite athletes undergoing surgical intervention.

The purpose of this study was to evaluate return to activity, both in absolute time and relative level of return, in a group of elite-level athletes after surgical fasciotomy for CECS. We hypothesized that the majority of elite-level athletes will successfully return to their previous level of competition following fasciotomy for CECS.

Materials and methods

Identification of patients

After approval from our Institutional Review Board was obtained, a review of billing records at our institution identified 41 patients treated with a fasciotomy for CECS of the lower leg at our institution between January 2009 and January 2012. Of these patients, 14 were identified as elite athletes. An elite-level athlete was defined as a person who participated in collegiate and/or professional athletics. Data were then collected via retrospective chart review, including patient demographics, sport or activity causing the symptoms, the duration of activity required to cause the symptoms, duration of symptoms prior to the surgical treatment, treatment prior to the surgical release, compartment-pressure measurements, surgical details, any complications, whether or not the patient was able to return to sport, level of sport return, and time required to return to sport. For patients who had operations on both limbs but on separate occasions, the time to return and ability to return after the most recent surgery was used for calculations. One patient was excluded from the analysis as she suffered multiple concussions unrelated to her diagnosis of CECS that prevented her from returning to elite-level competition, leaving 13 patients for analysis.

Surgical indications

Once the diagnosis was established with clinical examination and confirmed by treadmill compartment-pressure measurement following the guidelines established by Pedowitz and colleagues [15], a trial of nonoperative management was initiated. The standard treatment protocol at our institution consisted of 4–6 weeks of reduction or cessation of activities, nonsteroid anti-inflammatory drug (NSAID) use, stretching, and formal physical therapy (PT). However, in this specific patient population of elite athletes, a trial of reduction or cessation of activities was not generally plausible. Therefore, if these patients had an established diagnosis of CECS, a more aggressive timeline to surgical intervention was undertaken. Timing within the season was taken into account. If the athlete was in season and was able to tolerate the symptoms, surgery was delayed until the off-season. If the pain and/or symptoms were not tolerable, surgery was performed acutely.

Surgical technique

Patients were placed in the supine position on a standard operating table. The anterior and lateral compartments are approached via a longitudinal incision made over the distal third of the lower leg, midway between the fibular shaft and tibial crest. Subcutaneous tissue was bluntly separated from the fascia, and the anterior compartment and lateral compartment fascia were identified. Throughout the procedure, care was taken to identify and protect the superficial peroneal nerve. Initial small incisions in the fascia were made in a longitudinal direction. Palpation revealed the intermuscular membrane. With use of the long scissors, full-length fasciotomies were performed over both the anterior and lateral compartments. The fascia was then inspected and palpated to ensure complete release. The fascia around the superficial peroneal nerve was released without injuring the superficial peroneal nerve in order to relieve any entrapment.

For patients that had all four compartments involved, attention was then turned to the deep posterior and superficial posterior compartments. At approximately the level of the midcalf, 2 cm posterior to the posteromedial tibial cortex, a 4-cm incision was made through the skin. Subcutaneous tissue was dissected down bluntly taking care to identify the saphenous nerve. The saphenous nerve was then visually identified as well the saphenous vein and retracted. The fascia was identified, and a small knick was

made in the fascia overlying the deep posterior compartment. Long Metzenbaum scissors were used with a pushing technique from proximal to distal to incise the fascia. The scissors were reversed and taken in the distal to proximal direction avoiding any neurovascular structures, including release of the soleus bridge. Next, the superficial posterior compartment was identified. A small knick with a #15 blade surgical scalpel was made in the fascia. A pushing technique from proximal distal and then reverse distal to proximal was undertaken with Metzenbaum scissors, avoiding nerve and blood vessel injury. The tourniquet was released at this time, and meticulous hemostasis achieved. The wounds were then copiously irrigated and closed in layers.

Postoperative protocol

Patients had a soft dressing and compressive wrap placed after surgery. They were given crutches to help with ambulation in the immediate postoperative period, but they were instructed to bear weight as tolerated and to discard the crutches when they could easily get around without a significant limp. A dry, sterile gauze dressing was kept in place until first postoperative visit at approximately 1 week. At this time, sutures were removed and a formal rehabilitation program was started.

The goals of the initial phase of rehabilitation in the first couple of weeks included controlling extremity swelling and edema with elevation, ice, and compression wrap. Other goals included gait training with progression to full and painless weight bearing, maintaining/regaining ankle and knee range of motion, and gentle isometric strengthening. The next phase of rehabilitation leading up to the 6–8 weeks mark included goals of progressive strengthening of the lower extremity leading up to clearance for running, jumping, and sport-specific training and drills, which were not initiated until at least 6 weeks postoperatively.

Statistics

Summary statistics were calculated for all collected data. *t* tests were used to compare the time to return to sport based on whether patients underwent release of all four compartments or just the anterior and lateral compartments. Statistical significance was defined as $p < 0.05$.

Results

The 13 patients meeting the inclusion criteria (Table 1) participated in a wide variety of sports: football (3), track and field (2), soccer (2), field hockey (1), rugby (1), triathlons (1), speed skating (1), softball (1), and professional dancing (1). There were six males and seven females. The ages of the patients ranged from 17 to 24 years with a mean age of 19.7 years. None of the patients used tobacco, and the comorbidities were minimal: depression (2), asthma (2), gastroesophageal reflux disease (2), hyperthyroidism (1), anxiety (1), palpitations (1), and attention deficit disorder (1). The average length of follow-up was 11.3 months (range 2–60 months).

The mean duration of symptoms prior to the fasciotomy ranged from 1 week to 4 months. Six patients underwent unilateral lower extremity compartment release, and seven underwent bilateral lower extremity compartment release. Four of the patients who had bilateral releases underwent the procedures during the same anesthesia. There were three patients who underwent unilateral release followed by contralateral release a short time later. Three patients are identified in Table 1. The average time between surgeries was 6.3 months, with a range of 2–11 months. All three patients were initially symptomatic in only one leg before developing symptoms in the other leg after the original surgery. Only the anterior and lateral compartments were released in 11 of the 13 patients (84.6 %). The two patients that had all four compartments released had bilateral lower extremity surgery.

Although all 13 patients were able to return to sport at the previous elite level, 2 of the 13 patients (15.4 %) were unable to sustain their previous elite level of activity in their respective sport. These patients had to discontinue participation secondary to return of preoperative symptoms. Neither of these patients had posterior compartment releases. In total, 11 of 13 patients (84.6 %) were able to return to and maintain their previous elite level of sport participation following surgical fasciotomy for CECS during the follow-up period.

The exact time for a full return to all sporting activities was available in 10 of the 13 patients. These patients return to sport at an average of 10.6 weeks (range 6–24 weeks) following surgery. Two of the patients underwent concomitant surgery around the same time as the fasciotomy, resulting in a longer restriction from sport than was required for the fasciotomy itself. One patient underwent anterior cruciate ligament reconstruction while the other underwent a Bankart repair. When these patients were removed from the calculation, the average time to full return to all sporting activities was 8.25 weeks (range 6–12 weeks). Among these patients, those who underwent four-compartment releases returned to sport at an average of 11.0 weeks (range 10–12 weeks), compared with 7.3 weeks (range 6–9 weeks) for those who underwent only anterior and lateral compartment release ($p = 0.011$).

Complications were minimal in this group of patients. Minor complications included some pain at the incisions in one patient that resolved with massage and a positive

Table 1 Demographics

Patient	Sex	Sport	Comorbidities	Duration of symptoms	Compartment pressure	Unilateral versus bilateral	Compartments released	Return to sport at previous level	Time to return (weeks)	Return of symptoms
1	M	Football	None	1 week	Unavailable	Unilateral	Anterior and lateral	Yes	24^	No
2	F	Track	None	36 days	24/66/34, 49/65/44 Left and right anterior/lateral/DP	Bilateral	4 Compartments	Yes	10	No
3	M	Speed skating	None	1 week	35/17/37, 33/24/35 Left and right anterior/lateral/DP	Bilateral	4 Compartments	Yes	12	No
4	F	Field hockey	None	33 days	88/20, 66/18 Right and left anterior/lateral	Bilateral	Anterior and lateral	Yes	7	No
5	M	Triathlete	Depression	4 months	Unavailable	Bilateral	Anterior and lateral	Yes	8	No
6	M	Football	Gastroesophageal reflux	13 days	45/48 Right anterior/lateral	Unilateral	Anterior and lateral	Yes	6	No
7	F	Rugby	Viral meningitis	15 days	39/32 Right anterior/lateral	Bilateral	Anterior and lateral	Yes	–	Yes%
8	F	Track	None	11 days	65/17 Right anterior/lateral	Unilateral	Anterior and lateral	No	6	Yes
9	F	Softball	Asthma	9 days	119/85 Left anterior/lateral	Unilateral	Anterior and lateral	Yes	–	No
10	M	Soccer	Attention deficit disorder	Unknown	Unavailable	Bilateral	Anterior and lateral	Yes	9	Yes%
11	F	Soccer	Hyperthyroidism, palpitations	Acute onset	36 Left anterior at rest	Unilateral	Anterior and lateral	Yes	16#	No
12	F	Professional dancer	Gastroesophageal reflux, asthma, depression	4 months	32/20 Right anterior/lateral	Unilateral	Anterior and lateral	No	–	Yes
13	M	Football	None	Unknown	Unavailable	Bilateral	Anterior and lateral	Yes	8	No

– Information regarding exact time to return was unclear in the chart

^ Patient underwent concomitant ACL surgery, which prolonged return to play

Patient underwent concomitant labral repair, which prolonged return to play

% These patients had some return of symptoms but were able to maintain elite level of play

Tinel's sign of the superficial peroneal nerve bilaterally in another patient, which did not preclude a return to participation. Four of 13 patients (30.8 %) had a return of symptoms within the follow-up period. One of these four patients underwent revision surgery 22 months after his initial fasciotomy before ceasing elite-level sport participation, yielding a revision risk of 7.7 %. One other patient required additional time away from sport following initial return due to a recurrence of symptoms but was then able to return to sport after three additional weeks of rest without further symptoms. One other patient stopped elite-level participation due to recurrent symptoms and the final patient simply played through the residual symptoms. No other complications commonly seen in this operation such as infection, hematoma, seroma, deep venous thrombosis, or peripheral nerve injury [9] were found in this group of patients.

Discussion

The key finding of the current study is that 84.6 % of elite-level athletes were able to return to their prior activity level following surgical fasciotomy for CECS. This is the first case series to focus on fasciotomy for the treatment of CECS is elite-level athletes. There have been case reports of CECS successfully treated surgically in elite athletes. Both Goubier and Raphael [10, 16] reported on forearm compartment syndrome in two cyclists and a Major League Baseball pitcher, respectively. Farr and Selesnick [8] reported on successful surgical release in the lower extremity of a collegiate soccer player.

The results noted in elite athletes in the current study are comparable to those reported by previous authors in more general populations. Detmer et al. [6] reported that more than 90 % of a series of 100 patients were "cured or significantly improved" with fasciotomy. Styf and Korner reported a similar success rate of 89 % in 19 patients, and Schepsis showed a 96 % success rate in 26 patients without posterior compartment involvement [19, 22]. Some groups have not fared as well. Schepsis et al. [19] reported only 65 % good or excellent results in 20 patients with posterior compartment involvement. Similarly, Rorabeck showed 88 % return to athletics in 25 patients, with the three patients unable to return having posterior compartment involvement [17]. Waterman et al. [25] reported on a group of 611 military recruits (754 procedures) in which 44.7 % had symptom recurrence, 27.7 % were unable to return to full activity, and 17.3 % were referred for medical discharge. It is interesting to note that the two patients in our group who were unable to return to play secondary to recurrent symptoms had unilateral extremity involvement and no posterior compartment involvement.

In the current study, patients were able to return at full activity without restrictions at an average of 10.6 weeks (8.25 weeks among those who underwent no concomitant procedures). This finding compares favorably to previous reports in the literature [6, 7, 14, 17, 18, 22]. The return of symptoms is an unwanted complication that occurred in 30.8 % of patients in this group. This risk is slightly higher than the 21 % return of symptoms reported by Slimmon et al. [20] in a study of 62 patients with 51-month follow-up. However, only 1 of the 13 patients (7.7 %) required revision surgery, which is comparable to other reports, such as Howard et al. [12] who showed a 6 % revision rate.

There are several limitations of this study, including the small sample size and the retrospective design. Given the restriction of the study to elite athletes, small numbers are not surprising. This report does represent the largest series to date in this population, as previous publications of CECS in elite-level athletes have been case reports [10, 13, 16]. Further limitations include the relatively short follow-up (average 11 months). The focus of this paper is the return to sport of elite-level athletes following fasciotomy for CECS and the follow-up achieved in the current study is sufficient to evaluate this outcome measure. Further work is needed to assess the longer-term results of this procedure in the elite-level athlete population.

Return to sport at the previous level was demonstrated in 84.6 % of 13 elite-level athletes at a mean of 10.6 weeks following surgical fasciotomy for CECS of the leg. Involvement of four compartments resulted in longer return to full sporting activities after release. More research is required to evaluate the long-term outcomes of fasciotomy for CECS in this population.

Conflict of interest The authors of the present manuscript declare that they have not proprietary interest or conflict of interest. The authors of the present manuscript, Val Irion, Robert A. Magnussen, Timothy L. Miller, and Christopher C. Kaeding, declare that they have no proprietary interest or conflict of interest.

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