Isolated Chronic Exertional Compartment Syndrome of the Flexor Carpi Radialis

A Case Report

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Chronic exertional compartment syndrome (CECS) is a well-known condition in sports medicine that is characterized by reversible recurrent ischemia to the muscle due to an increased pressure within a limited space in a muscular compartment.[4] Typical symptoms include pain, tenderness, paresthesia, weakness, and cramping. It is most commonly observed in the lower extremities frequently affecting the tibialis anterior muscle compartment in runners and walkers.[1,3,13,19] CECS of the upper extremity was less frequently reported in literature.‡

Case reports concerning CECS in the forearms were associated with motorcycling,[5,15,28] kayaking,[21] rowers,[10] tennis,[2] wheelchair athletics,[27] climbers,[7,23,28] or heavy manual work.[5,26]

Continuous and excessive movements of the wrist and fingers during climbing result in an extreme stress on the deep flexor muscles leading to their exhaustion, which limits a climber's performance.[24] Exhausting climbing performance is usually associated with "pumped" forearms (hard, swollen forearms). This pumped sensation is normal after climbing and therefore cannot be used as an indicator for CECS. Schoeffel et al[23] measured physiological standard pressure of the flexor muscles during exercise and revealed that only a prolonged pumped sensation of more than 15 minutes after exercise can be associated with CECS. Only a few cases of CECS in climbers have been published, all of them affecting the forearm flexor compartment. Definitions concerning anatomic configuration of the forearm compartments diverge, referring from 4[3,10] to 10[9] defined compartments. We consulted 1 climber with a clinical sign of a CECS but normal intracompartmental pressure (ICP) in the deep and superficial flexor compartments after a climbing-specific stress test. In the case presented, the individual diversity of anatomic configuration of the forearm compartments created a diagnostic challenge. To our knowledge, the following case report is the first description of an isolated CECS of the flexor carpi radialis compartment for a rock climber.

‡ References 2, 5, 7, 8, 10, 15, 21, 23, 26, 28.

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CASE PRESENTATION

A 20-year-old male rock climber complained of recurrent pain for 12 months in a distinct area on his left proximal forearm during the past year, especially during and after multipitch climbing (long climbing routes with 1 or more stops at belay stations). The patient noticed a mild swelling of the forearm after climbing, and the painful pumped sensation in his forearm usually persisted during several hours even while resting. Clinical investigation revealed no abnormalities during inspection; however, a mild tenderness was found in the flexor-pronator muscle group of his left forearm. There was no loss of functionality, no dysesthesia, and no indication of impaired perfusion; no medication intake and no other diseases were known, and because of the chronic course of the disease, the differential diagnosis of a rhabdomyolysis was very unlikely. Nonoperative and functional treatment with reduction of climbing volume and active relaxation as well as extensive stretching of the forearm muscles for 9 months failed to alleviate the pain. Eventually, the compartment pressure was

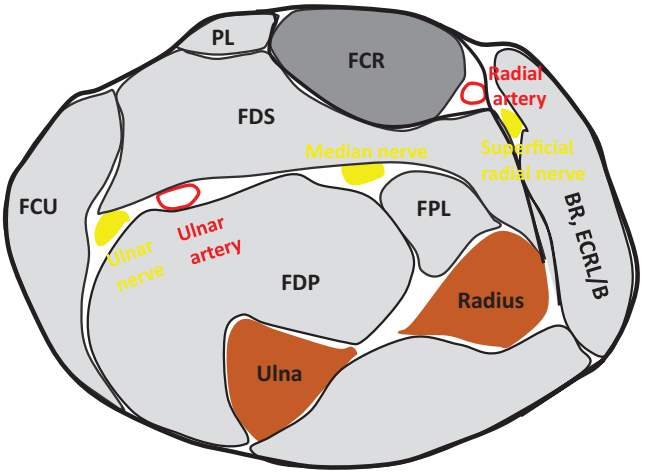

Figure 1. Cross section of the forearm illustrating an isolated compartment of the flexor carpi radialis. BR, brachioradialis; ECRL/B, extensor carpi radialis longus/brevis; FCR, flexor carpi radialis; FCU, flexor carpi ulnaris; FDP, flexor digitorum profundus; FDS, flexor digitorum superficialis; FPL, flexor pollicis longus; PL, palmaris longus.

measured with ultrasound assistance before and right after a climbing-specific stress exposition through repeated dynamic finger and wrist flexion. Before the stress exposition, the pressure reached 11 mmHg in the profound flexor compartment and 15 mmHg in the superficial flexor compartment and immediately after the exercise 14 mmHg and 26 mmHg respectively. As the patient noted that the exact point of pain was not targeted yet, an additional pressure measurement was conducted in the area of the flexor carpi radialis. This measurement revealed a pressure of over 40 mmHg around 5 minutes after the stress exposition had taken place in the compartment of the flexor carpi radialis (Figure 1).

As a result of this increased pressure and the according symptoms, a CECS was diagnosed and an endoscopically assisted fasciotomy was performed. The patient was in a supine position with the arm in 90° abduction and a tourniquet at the upper arm with 250 mmHg inflated. A 3-cm incision (Figure 2) was made over the flexor carpi radialis muscle belly 12 cm distal to the medial epicondyle.

Blunt dissection of the fascia along the flexor carpi radialis was performed with assistance of a 4.5-mm, 30° endoscope with an optical dissector (50200 ES; Karl Storz). The fascia was incised and split along its entire length with scissors under visual control of the endoscope. The intraoperative findings revealed an isolated compartment of the flexor carpi radialis, which was then released (Figure 3).

Moreover, the fascia of the flexor-pronator muscle group was split also about 3 cm to the ulnar side from the first fasciotomy to prevent the later development of a CECS in this compartment. The wound was closed with a No. 4-0 Prolene intracutaneous suture (Ethicon). Postoperative results were good at the 2-month follow-up and the patient was able to start climbing easy routes. At the 12-month follow-up, the patient had almost returned to his maximum

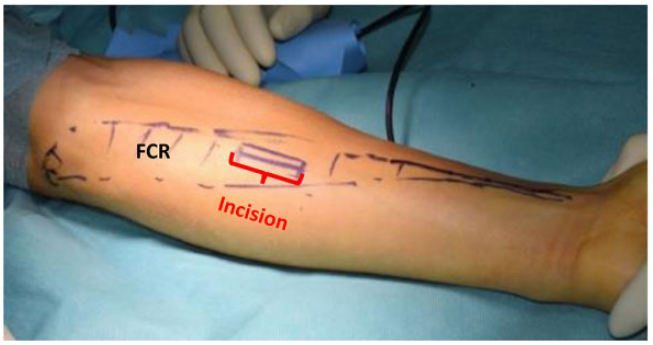

Figure 2. Preoperative planning of the surgical approach to the flexor carpi radialis (FCR).

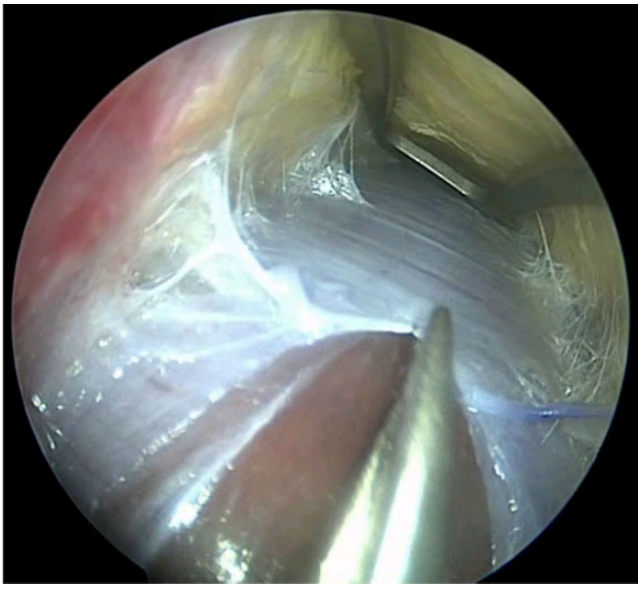

Figure 3. Endoscopic-assisted fasciotomy of the compartment of the flexor carpi radialis using the optical dissector 50200 ES (Karl Storz).

performance level with no remaining symptoms concerning the compartment syndrome. Therefore, there was no indication for a repeated ICP (intracompartmental pressure) measurement postoperatively. The only remaining complaints were associated with the rehabilitation of the indurated fascial scar.

DISCUSSION

We demonstrate a case report of an isolated CECS to the flexor carpi radialis that underwent endoscopic fascial release after failed nonoperative treatment in a climber. The patient returned to all climbing activity after 1 year with no persistent symptoms. A pumped sensation in the forearms after climbing is a normal condition. Some climbers, however, suffer a repeated prolonged (>15 minutes) painful pumped sensation after climbing caused by an increased ICP

in the forearm. A compartment syndrome is caused when the ICP increases over the capillary level.[18,25] Patients with CECS show a high ICP at rest, an abnormally high ICP during exercise, or a slow return to normal ICP after exercise.[16,23] Normal physiological forearm ICP was assessed in several studies and found to be between 7.3 mmHg and 10 mmHg [2,23] at rest. However, ICP at rest in a weight lifter reached 22 mmHg.[14] Mean pressure immediately after a climbing-specific stress test has been reported to be 19 (±7.14) mmHg and usually decreased within 3 minutes to normal values.[23] Depending on the physiological conditioning, high ICP of up to 95 mmHg can be tolerated without causing any pain.[2] In an attempt to facilitate the diagnosis of CECS in the forearm, a threshold value was proposed suggesting diagnosis of CECS when pressure exceeds 30 mm Hg more than 15 minutes after climbing-specific stress exposition.[23] A considerable challenge is the wide range of physiological pressures and the absence of an absolute threshold pressure, which impedes the establishment of universal guidelines for diagnosis of CECS in the forearm.

To our knowledge, only 3 cases of forearm CECS associated with climbing have been reported to date. Schoeffl et al[23] observed 1 case with bilateral CECS in a climber where pressures in the flexor compartment exceeded 50 mmHg after climbing and Zandi[28] reported 1 case of a bilateral CECS in a climber where flexor compartment pressures reached 44 mmHg. Both patients regained unrestricted function and full performance level after bilateral fasciotomy. Drouet et al[7] described another case of bilateral CECS in a climber associated with rhabdomyolysis but without irreversible damage. This patient refused fasciotomy because he stopped his athletic activities. In the 3 previously described cases associated with climbing, CECS occurred bilaterally possibly due to hypertrophic muscles on both sides. However, our patient did not show any symptoms in his right arm, and anatomic configuration of the volar compartments of his right forearm remain unknown.

The anatomic configuration of the forearm compartments is less distinct than in the lower extremity, and a variety of potential facial enclosures exist. Chan et al[6] defined 3 volar compartments: (1) pronator quadratus, (2) superficial flexor, and (3) deep flexor; and Fröber and Linss[9] reported 5 forearm compartments: (1) ulnar extensor, (2) dorsal extensor, (3) radial, (4) superficial flexor, and (5) deep flexor. Van der Zypen[27] in turn described 10 forearm compartments: (1) superficial extensor, (2) deep extensor, (3) extensor carpi radialis, (4) extensor carpi ulnaris, (5) flexor digitorum profundus and flexor pollicis longus, (6) flexor digitorum superficialis, (7) flexor carpi radialis, (8) pronator teres, (9) brachioradialis, and (10) flexor carpi ulnaris. Theoretically, each potential compartment should be assessed in patients with suspected CECS; however, the deep flexor compartment seems to be most commonly affected. Fewer cases described CECS of the superficial flexor compartment or the extensor compartment. Yet, to our knowledge, an isolated CECS of the flexor carpi radialis was not previously described in literature.

As previously concluded, the prevalence of CECS in the upper extremities is highest in young adults and predominantly male athletes,[7] which applies to our patient. Although the etiology of the disease remains unknown, it is most commonly associated with a history of excessive exercise of the forearm muscles. Kutz et al[16] observed a case of CECS 4 months after a crush injury due to severe fibrosis that caused a decrease in the residual compartment space in the forearm. Fascial thickening was described in several other cases[20,21,28]; however, it was not observed in our patient. Among the reported cases of forearm CECS, clinical presentation was rather uniform, including pain, pumped sensation, weakness, and swelling. In some cases, neurological symptoms and numbness in the fingers were reported. Pedowitz and Toutounghi[20] found a constriction of the median nerve at the level of the flexor carpi ulnaris through a tight aponeurotic band that had to be released in addition to flexor compartment release. Treatment of choice in CECS is fasciotomy of the involved compartments, as good results can be expected thereafter.[1,4,22] Piasecki et al[21] suggest preoperative exertion to facilitate the intraoperative decision in which compartments are involved and need to be released. Although open fasciotomy remains the gold standard, endoscopic-assisted fasciotomy has recently become more popular.[10] While open compartment release requires large incisions, endoscopic procedures offer fewer complications associated with scarring, more cosmetically pleasing incisions, and faster recovery. When performed by experienced surgeons, the endoscopic technique provides a safe and effective approach with excellent visualization of neurovascular structures.[11,12,17] Although we were able to measure normal pressure in all other compartments except the flexor carpi radialis, we decided to open the fascia of the flexor-pronator group prophylactically as well, as this was easily possible by the same incision to prevent a potential development of a later CECS in the other flexor-pronator compartment. There is no report in the literature supporting conservative treatment to improve symptoms if patients kept performing inciting activities.[5] In recent years, a considerable number of reports affecting CECS in the forearm were published, and thus this condition is becoming increasingly important in sports medicine. Raising the awareness of this disease might contribute to early diagnosis, treatment, and a fast return to premorbid performance levels of athletes.

CONCLUSION

A CECS in the forearm should be considered as a differential diagnosis in climbers with a recurring prolonged painful pump after climbing. Individual anatomic configuration of the forearm compartments may account for a diagnostic challenge and an isolated CECS of the flexor carpi radialis compartment can occur, which may require precise ultrasonographic-guided measurement of ICP. Prognosis after a fasciectomy is good and the patient can return to climbing without remaining symptoms.

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