CASE REPORT

# Results of compartment decompression in chronic forearm compartment syndrome: six case presentations

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**Background:** There are few reports concerning chronic compartment syndrome producing symptoms in the forearm, although in the lower limb this is a well recognised condition. The objective was to demonstrate that chronic compartment syndrome is a cause of exercise induced forearm pain and transient upper limb dysfunction and that forearm compartment decompression can reliably relieve the associated symptoms.
**Methods:** Six patients with a flexor compartment chronic compartment syndrome, documented by pressure studies, had forearm compartment decompression.
**Results:** All patients had good relief of their exercise associated forearm pain following the decompression. Widening of the incisional scar was frequently reported.
**Conclusion:** Forearm compartment decompression is effective in relieving the symptoms related to chronic forearm compartment syndrome.

Exercise induced pain due to chronic compartment syndrome is a well recognised condition in the lower limb, with many reports in the literature, some of which include the results of surgical decompression of the involved compartments.[1–5] However, there is little in the literature concerning chronic compartment syndrome affecting the upper limb, and most papers are single case reports.[6–9]

Over a 9 year period, the senior author treated six cases of exertional compartment syndrome affecting the forearm. In all cases the flexor compartments were involved and surgical decompression was carried out. In one case, the extensor compartment was also decompressed. The results in these cases are presented.

## METHODS

Six patients with chronic exertional compartment syndrome of the forearm, who presented over a 10 year period and were treated with surgical compartment decompression, were reviewed. Preoperative and operative details were obtained retrospectively from the case notes. All patients were followed up with a written questionnaire and telephone interview. All six were males, with an average age of 26 years. The group included one wheelchair athlete with spina bifida, two motorcyclists, two water skiers, and a mountain climber. The follow up period was 6 months to 9 years, with an average of 5 years.

### Surgical technique of forearm flexor compartment decompression

Under general anaesthesia a tourniquet is applied and the forearm is exsanguinated. A 4 cm longitudinal incision is made over the flexor pronator compartment, distal to the inferomedial border of the cubital fossa. Within the subcutaneous zone, the branches of the medial cutaneous nerve of the forearm are identified and preserved. The bicipital aponeurosis is released longitudinally. Within the cubital fossa, the median nerve is identified medial to the biceps tendon and, more distally, the radial artery is identified over the lateral border of the pronator teres. The median nerve exits under the fibrous superficialis arch and over the deep head of the pronator teres. The fibrous superficialis arch and any aberrant bands are released. The fascia over the flexor pronator compartment muscles is released longitudinally and transversely, and a partial elliptical fasciectomy is performed. Care is taken to release each muscle in this group including pronator teres, flexor carpi radialis, palmaris longus, and flexor carpi ulnaris.

At the end of the operation the tourniquet is released, haemostasis is achieved, and a suction drain inserted. The subcutaneous layer is closed with continuous absorbable suture, with subcuticular Prolene (Ethicon, Somerville, NJ, USA) for the skin. A compression bandage is then applied from the elbow to the hand.

Post operatively, the bandages are kept intact for 2 weeks with the arm rested in a sling, with intermittent application of ice. At 2 weeks post operation, the patient commences normal daily activities and an exercise program, such that by 6 weeks post operation they are able to commence normal exertional activity.

## CASE REPORTS

### Case 1

A 23 year old right handed professional wheelchair athlete, with spina bifida at T12, complained of exercise related pain in the brachioradialis area to the dorsal and volar regions of the forearm. This developed within half an hour of commencing wheelchair sports. He described a sense of ''loss of control'' in his hand. There was no associated numbness. With onset of pain he would cease exertion and within 10 min he would be pain free. He found that massaging the forearm improved the symptoms.

Examination revealed well developed upper limb musculature. Mild tenderness was present around the lateral epicondyle. A provisional diagnosis of chronic exertional compartment syndrome affecting both the extensor and flexor compartments was made. Compartment pressure studies were carried out which demonstrated elevated pressure, however the record of the technique and the actual pressure is not available.

Operation involved decompression of both the extensor and flexor compartments. A standard volar, and also a dorsal incision 5 cm distal to the lateral epicondyle, were made. A thickened investing compartment fascia was noted. Through the lateral incision, the fascia over the extensor compartment muscles, including extensor carpi ulnaris, extensor digiti minimi, extensor digitorum communis, extensor carpi radialis longus and brevis, and brachioradialis, was divided longitudinally and transversely. The forearm flexor

compartment was decompressed in the standard manner described above.

Post operatively, he had 2 weeks of rest, 2 weeks of light training, and then at 6 weeks returned to full training.

At 9 year review, he continues to be a full time professional athletic wheelchair sprinter and is a Para Olympian. He was pleased with the outcome of his surgery. He reported that the skin scars had widened and stretched, however the cosmetic aspects of this did not concern him. He had achieved a high level of recognition in two Para Olympics by winning three gold and three bronze medals.

### Case 2

A 26 year old right handed professional motorbike racer presented with a 5 year history of gradual worsening of symptoms in the right forearm. He described pain in the volar aspect of the forearm, which felt like ''bursting'' after five laps around the circuit. He also described a sense of ''loss of strength and control'' in the hands, and had very mild exertional numbness in the fingers but no true paraesthesia.

Neurological examination was normal. The forearm felt tight at rest. Compartment pressure tests were performed with repetitive dumbbell flexion at the wrist. Subjectively this manoeuvre did reproduce some pain and swelling, but not as severe as when he was racing on the motorcycle. Single stab reading of the pressure in the flexor compartment using the Stryker (Kalamazoo, MI, USA) sideport needle recorded a post exercise pressure of 32 mm Hg, and with finger flexion this increased to 54 mm Hg.

In April 1996, standard right forearm flexor compartment decompression was carried out as described above. The fascia was noted to be thickened .

On review at 2 weeks, he had marked bruising in his forearm, normal range of motion, and no neurological sign or symptoms.

At review by phone, after 6 years, he stated that he was not happy with the cosmetic outcome of his surgery. Over time the volar scar had widened and stretched. He attributed this to the post operative haematoma and bruising. Functionally, however, he admitted that he was doing well and no longer had his preoperative symptoms. He owns a motorcycle outlet and reached second place in last year's motor cycling tournament.

### Case 3

A 31 year old sales clerk experienced claudicant right forearm pain first brought on by the simple act of handwriting. After heavy manual work, such as hammering, a feeling of uselessness and fatigue in the forearm took up to 3 days to subside. He also had sense of numbness in the ulnar sided fingers. Clinical examination was unremarkable; in particular, there were no clear signs of ulnar nerve involvement. Nerve conduction studies were all normal. Slit catheter study[10] of the right superficial forearm flexor compartment showed a pre-exercise pressure of 10 mm Hg rising to 98 mm Hg with exercise using a dumbbell. The pressure was recorded as 33 mm Hg after 10 min of rest. He then underwent forearm flexor compartment decompression in the standard manner described above. At a recent follow up, some 6 years post index operation, his symptoms had completely subsided. He reported that the scar was a little wide but that this did not concern him.

### Case 4

A 24 year old mountain climber presented with bilateral symptoms of chronic exertional forearm compartment syndrome. He had physiotherapy without benefit. His symptoms were very similar to those described by the subjects mentioned above and had gradually increased to the stage that he was unable to rock climb. Resting pressures were not recorded. His post exertional flexor compartment pressure was measured, using the slit catheter technique, to be 44 mm Hg.

He underwent bilateral forearm compartment release in the standard manner described above but without release of the median nerve. Within 2 months he had complete relief of his previous symptoms. He successfully returned to unrestricted mountain climbing.

### Case 5

A 26 year old fitter and turner was initially referred to the senior author (SNB) because of bilateral anterior and posterior compartment lower limb symptoms consistent with exertional compartment syndrome and had successful lower limb compartment decompression.

He was referred again in 2001 with symptoms in his upper limb suggestive of bilateral exertional compartment syndrome. His symptoms initially developed mainly after water skiing. He found that after skiing he was not able to hold a cup and had numbness in his fingers. He also described cramping of the forearm and thumb. He later started to note these symptoms when riding his motorbike, particularly with repetitive use of the brakes, clutch, and throttle. The pain was mainly in the flexor pronator compartment with some extension into the dorsal extensor compartment region.

On examination, the flexor compartment appeared tense at rest. Neurological examination was normal. Compartment pressures were measured in the right flexor compartment using the Stryker sideport needle. He performed a series of flexion curls to reproduce his troubling symptoms. At 1 min post exercise pressure was 43 mm Hg, and at 5 min post exercise it was 38 mm Hg.

He then underwent standard bilateral forearm flexor compartment decompression in the manner described above. Thickened fascia was found. On the right, a tight band of tissue was noted to be crossing the median nerve, just proximal to its entry into the fibrous superficialis arch. The band and the fibrous arch were released. The above mentioned band was not noted on the left side and just the fibrous arch was divided.

Post operatively he had bandages and ice for 2 weeks. He started to use the arm at 2 weeks and returned to motorcycling at 6 weeks.

At phone review 9 months following his operation he stated that he was very satisfied with the operation. He had returned to his premorbid level of sporting activity and no longer suffered from cramping and pain in the forearm. He reported that the incision had widened to about 10 mm.

### Case 6

A 25 year old right handed office worker was first seen in April 2002. Over the previous 15 months he had noticed the development of pain and tightness in both forearms with water skiing. Loss of power and grip function occurred following the onset of pain. He reported that it would take up to 2 h for the symptoms to completely resolve. He also described an unusual feeling of numbness over the region of the medial epicondyle extending to the two ulnar innervated fingers, which was associated mainly with driving. Clinical ulnar nerve tests were normal apart from a very mildly positive Tinel sign at the elbow.

Forearm flexor compartment pressure measurements were performed using the Stryker sideport needle technique. The resting pressure was not recorded. The muscles were exercised using a dumbbell. The medial forearm flexor compartment became very tense and painful. At 1 min after cessation of exercise, the pressure was measured as 42 mm Hg and at 5 min it was 36 mm Hg.

## What is already known on this topic

There are few reports concerning chronic compartment syndrome producing symptoms in the forearm, although in the lower limb this is a well recognised condition

## What this study adds

Forearm compartment decompression is effective in relieving the symptoms related to chronic forearm compartment syndrome

Bilateral forearm flexor pronator compartment decompression was performed according to the technique described above. On review 6 months post operatively, he was asymptomatic and the ulnar nerve symptoms had also resolved.

## RESULTS

All patients were young males and all relied on their forearms and upper limbs quite intensely. Post operatively they have all returned to their desired sporting activity and are symptom free. From a cosmetic point of view, most described a widening of the scar.

## DISCUSSION

The literature concerning chronic forearm compartment syndrome consists mainly of individual case reports. Most of these reports describe forearm flexor compartment syndrome,[7 9 11 12] while a few describe forearm extensor chronic compartment syndrome.[8 13 14] We can only find one other case of exertional compartment syndrome of all four extremities,[9] as was seen in our case 5. The senior author's practice involves both sports orthopaedics and upper limb surgery, hence the varied case mix of patients referred with this condition over the 9 year period. To our knowledge, no other single report has presented so many cases with chronic forearm compartment syndrome.

Most of the literature on chronic exertional compartment syndrome concerns the anterior and posterior compartments of the lower limb. It has been previously reported that patients with chronic exertional compartment syndrome have an elevated intra-compartmental pressure compared with normal.[15–17] The normal resting forearm pressure is believed to be between 0 and 15 mm Hg.[18] In cases of chronic exertional compartment syndrome, the pressure in the compartment rises during exercise. This is thought to be related to increased muscle bulk and tightness of the fascia aggravated by expansion by up to 20% in volume of exertional muscles during exercise.[19] Under normal circumstances exertional hyperaemia and swelling of the muscles settles within a few minutes and pressures return to normal at the same time.[16] In the lower limb a resting pressure greater than 15 mm Hg or a 5 min post exertional pressure greater than 25 mm Hg is considered to be abnormal.[7 20 21] We could find no control studies of compartment pressure in the forearm muscles during exercise. From our experience with the patients presented, it would appear that the normal pressures in the upper limb might be lower than in the lower limb. One of our patients had a resting pressure of 10 mm Hg and had a good result with decompression. All patients who had pressure measurements 5 min post exertion, showed a value greater than 30 mm Hg. It would appear from our series that dynamic compartment compression measurement is of benefit in confirming the clinical diagnosis of chronic compartment syndrome of the forearm.

All six patients reviewed used their upper limb quite intensely during their sport. The pattern of muscle use in their sport was continuous, with intermittent prolonged intense contractions with only short periods of rest. This pattern of exercise could tend to produce chronic compartment syndrome.

The most common symptom in our patients was a vague aching pain in the forearm sometimes radiating into the hand. The patients used the terms ''useless'', ''bursting'', and ''loss of hand control''. They clearly associated the pain and other symptoms with exertion and reported that the symptoms settled with rest, although slowly at times. Not all patients described only forearm pain and tightness as their main symptom. Some had neurological symptoms, some reported transient hand dysfunction, and others described cramps. Thus, chronic compartment syndrome must be considered as a differential diagnosis in any upper limb exertion related dysfunction.

A number of our patients reported associated neurological symptoms and numbness in the hands. In one case, a tight band was noted across the median nerve in the region of the fibrous superficialis arch. Pedowitz and Toutounghi reported a similar band.[7] They explored both the median nerve and the ulnar nerve and noted a constriction at the level of the flexor carpi ulnaris.

It was found in a number of our cases that the incisional scar had stretched with time and had become quite wide. The width in one case was 10 mm. It is important, therefore, to warn the patients of the potential detrimental cosmetic side effects of the procedure.

From the cases presented here, it would appear that patients with a true chronic compartment syndrome of the forearm do benefit in the long term from forearm compartment decompression.

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The patients mentioned in this case report have agreed to their details being published.

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