Mini-invasive Surgery for Chronic Exertional Compartment Syndrome of the Forearm

A New Technique

Pierre Croutzet, MD, Romain Chassat, MD, and Emmanuel H. Masmejean, MD, PhD

Abstract: Chronic exertional compartment syndrome is now easily identified among the athletic population. It remains common in motorcyclists. The only treatment is the fasciotomy of the compartments and the gold standard procedure is still the open-invasive surgery. The authors describe a new mini-invasive surgical procedure to perform a 4-compartment fasciotomy of the forearm, and expose their results.

Over a 3-year period, we reviewed 16 cases of forearm compartment fasciotomy for 8 patients with bilateral chronic exertional compartment syndrome of the forearm who had been operated on. All 8 were males, with an average age of 23 years. All were competition motorcyclists, either in cross-country or speed competitions. They were all treated with the same bilateral procedure: a mini-open fasciotomy of the 4 forearm compartments using the Knifelight, which is a sharp blade between 2 plastic blunt skids originally designed for carpal tunnel release.

All patients had resumed their sport in the 6 weeks after the surgery. They were back to their previous level in 3 cases, and improved their level in 5 cases. No complications and no recurrences were reported during an average 2-year follow-up. The mini-invasive technique for fasciotomy seems to be as efficient as the open technique procedure, which is still the gold standard. But the length of surgery, recovery time, and scar sequelae are much better. Mini-invasive surgery is simple, efficient, and the results are reproducible.

Key Words: chronic exertional compartment syndrome, forearm, mini-invasive surgery, Knifelight

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HISTORICAL PERSPECTIVE

Chronic exertional compartment syndrome was first described for the lower limb and has now been identified in upper limb for more than 20 years. Chronic exertional compartment syndrome of the forearm has been identified in athletic population, especially in motorcycling.[1] Although several hypotheses have been formulated, we still do not know which specific characteristics explain why chronic exertional compartment syndrome of the forearm is more common in certain sports rather than others. Professional athletes cannot give up their sports and medical treatments are known to be inefficient, so the only treatment is the fasciotomy of the compartments, and the wide open invasive procedure is still the gold standard. The authors describe a new mini-invasive surgery procedure to perform a 4 compartment fasciotomy of the forearm and present their results with an average 2-year follow-up.

From the Georges Pompidou European Hospital (HEGP), Paris, France.
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Authors declare they have all the patient consent forms.
Address correspondence and reprint requests to Emmanuel H. Masmejean, MD, PhD, Hand Surgery Unit, Georges Pompidou European Hospital (HEGP), Paris Descartes University, 20 rue Leblanc, 75015 Paris, France. E-mail: emmanuel.masmejean@egp.aphp.fr.

Forearm Compartments

In the forearm, 4 divided compartments are usually described (Fig. 1).[2,3]

The lateral compartment includes the extensor carpi radialis longus, extensor carpi radialis brevis, and the brachio-radialis.

The dorsal compartment includes: the extensor digitorum communis, extensor carpi ulnaris, the extensor digiti minimi and the deeper abductor pollicis longus, the extensor pollicis brevis, the extensor pollicis longus, the extensor indicis, and the supinator.

Most authors consider 2 volar compartments:[4,5]

- The superficial volar compartment: pronator teres, palmaris longus, flexor digitorum superficialis, flexor carpi radialis, and the flexor carpi ulnaris.
- The deep volar compartment: the flexor digitorum profundus, flexor pollicis longus, and the pronator quadratus.

INDICATIONS

Diagnosis

A pain appearing with effort and disappearing at rest is the main symptom. Certain sensory disorders (paresthesia) may be felt in the fingers. The compartment is firm and stiff, these symptoms often make sportsmen cease the exertion and they lose the pain within 30 minutes after the effort.[6] The symptoms may be steady or increase with time.

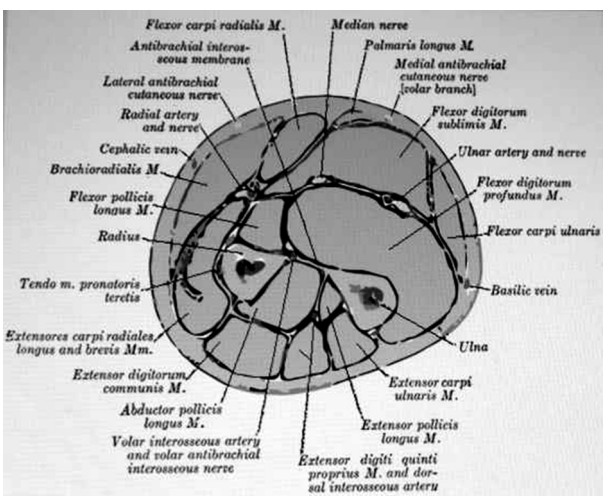

FIGURE 1. Diagram to show a cross-section through the middle third of a right forearm; R: Radius; U: Ulna, muscle initials in text.

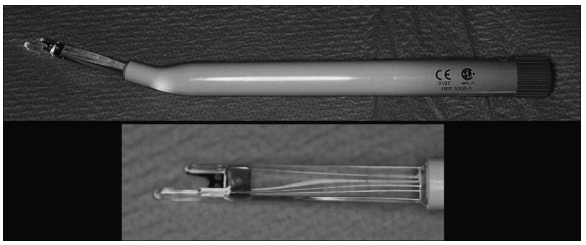

FIGURE 2. The Knifelight (Stryker).

Not all patients described only forearm pain and tightness as their main symptoms. Some reported transient hand dysfunction, and others described cramp.[1]

The diagnosis should be confirmed by dynamic measurements of compartment pressure. The measurements can be made with Stryker "STIC catheter" when the subject is at rest,[7] during the exertion period and the postexertion period; the outcomes are declared positive when the pressure during effort is over 30 mm Hg in 1 of the 4 compartments; no other paraclinical examination is usually necessary.[8,9]

Patients

Eight promotorcycle competitors presented with bilateral chronic exertional compartment syndrome of the forearm, over a 3-year period. They were all treated in the Hand Surgery Unit by the same senior surgeon with bilateral surgical compartment decompression.

Preoperative and operative details were obtained retrospectively from the case notes. All patients were followed-up with a written questionnaire and clinical examination.

All 8 were males, with an average age of 23 years (19 to 29). The group included 8 competition motorcyclists (7 Motocross including 1 supermotard word champion and 1 speed racer). They were right-handed in all cases, 2 were students, 1 a full professional, and 5 were manual workers. None were smokers. They practiced motorcycling 9 hours to 18 hours per week and they all practiced bodybuilding between training periods. Three of them had a previous trauma of the forearm, 2 wrist fractures, and 1 diaphysal fracture of the forearm.

The symptoms lasted an average of 18 months (7 mo-4 y) and became worse during the last 3 months in all cases. The compartment syndrome was bilateral in all cases, the right forearm was more symptomatic in 5 cases, the left forearm in 2 cases, and identical in 1 case.

Symptoms began within an average of 5 minutes (3-10 min) from the beginning of the motorcycle training or competition and disappeared within an average of 25 minutes (10-60 min) after training.

FIGURE 3. The volar landmark.

The pain was both volar and dorsal in 7 cases, and dorsal only in 1 case. This latter patient had previously sustained an open fasciotomy of the volar compartments of both forearms.

The clinical rest examination was normal in all cases: full motion of the wrist and elbow, no pain at rest, no sensitive disorders and the radial pulse was present.

Forearm x rays were all normal and in 3 cases, showed sequelae from previous fractures.

Dynamic pressure was measured inside the superficial volar compartment and dorsal compartment for 6 patients: these results were positive (over 30 mm Hg during effort) for all compartments of the 2 forearms for 4 patients, positive only for the volar compartment for 1 patient, positive in only 1 forearm for 1 patient. For 2 patients, the pressure was measured only for the volar compartment: these 2 results were negative. Indeed, the diagnosis for these 2 patients was only based on the clinical examination.

TECHNIQUE

The principle is to take advantage of the endoscopic procedure, but with all the simplicity of a single use knife: the Knifelight (Fig. 2). This instrument has its own battery-powered light source and a sharp blade between 2 plastic blunt skids. It was originally designed for carpal tunnel release but can be used in other ways.[10]

The surgery was performed with the patient on his back, under general anesthesia (bilateral procedure) with a tourniquet. This is an outpatient procedure.

FIGURE 4. Proximal and distal section of the superficial volar fascia.

FIGURE 5. Three-dimensional control with transillumination.

We considered that the 4 compartments (superficial volar, deep volar, lateral, and dorsal) should be released and it was not necessary to release the pronator quadratus compartment.

The surgery consisted of a mini-open fasciotomy with 2 approaches, 1 volar for the superficial and deep compartments and 1 dorsal for the dorsal and lateral compartments.[11,12]

The surface landmark of the volar approach (Fig. 3) was the line between the medial epicondyle and the intersection of the palmaris longus with the proximal flexion crease of the wrist.[13] Two skin incisions 3 cm each were performed along this line, one 7 cm distal to the epicondyle, and the other 7 cm distal to the first incision.

After skin incision, the forearm fascia was identified, the superficial cutaneous medial nerve of the forearm was placed on a surgical loop and the superficial veins were respected. An incision was made in the fascia, blunt dissection was performed above and below this; then, the 2 blunt skids of the Knifelight were placed above and below the fascia and the instrument was firmly but smoothly pushed proximally so that the blade between the 2 skids divided the fascia; primary in the proximal direction (Fig. 4) then in the distal direction (Fig. 4). We checked the section from the front view with transillumination (Fig. 5) and in depth with the distal skin window incision (Fig. 6).

FIGURE 6. Safe section with the skin window incision.

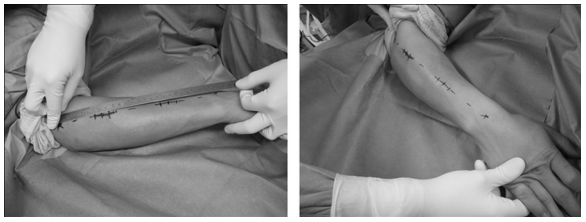

FIGURE 7. The dorsal landmark.

Then, to release the deep volar compartment, the dissection through these 2 skin incisions went deeper between the flexor carpi ulnaris and the flexor digitorum superficialis, aiming for the deep volar fascia overlying the flexor digitorum profundus. The deep volar fascia was incised with a regular knife in its full length.

The surface landmark of the dorsal approach was the line between the lateral epicondyle and Lister's tuberosity (Fig. 7). Two skin incisions 3 cm each (Fig. 7) were performed along this line, one 7 cm distal to the epicondyle, and the other 7 cm distal to the first incision.

Then, we could easily identify the fascia between the dorsal and lateral compartment and each compartment was released one after another with the same procedure as the volar approach.

At the end of the operation, the tourniquet was switched off, hemostasis was achieved, and a suction drain inserted (1 anterior and 1 posterior). The subcutaneous layer was closed with continuous absorbable sutures, and the skin was stitched with 4/0 Ethilon. A bandage was then applied from the elbow to the hand. The first dressing was applied 1 day after and the drain removed on the first or second day after surgery.

Postoperatively, the bandages were changed every 2 or 3 days for 2 weeks. Two weeks after the operation, the stitches were removed and patients began their normal daily activities and an exercise program, so that 6 weeks after their operation they could resume normal exertional activity.

COMPLICATIONS AND RESULTS

The follow-up period was 19 months to 36 months, with an average of 27 months.

All 8 patients representing 16 cases were very satisfied. All were able to resume motorcycling after 6 weeks of rest and they were all symptom-free. They were back to their past level in 3 cases and had actually improved their level in 5 cases.

No postoperative complications were reported (hematoma, nevroma).[14,15] The maximum follow-up was 3 years and no recurrence was noted.

The main complications reported in literature were venous lesions and superficial nerve lesions, neither tendon nor motor nerve impairment was reported.[16,17]

However, we found in 1 case hypertrophic proximal volar scar, for the other 15 cases, the cosmetic results have been judged excellent.

We achieved 15 excellent results and 1 good result regarding the inesthetic proximal volar scar.

In conclusion, the mini-invasive fasciotomy technique seems to be as efficient as the open procedure, which is still the gold standard. However the length of surgery, recovery time, and scar sequelae are less significant. This mini-invasive surgery is simple, efficient, and the results are reproducible without the complexity of arthroscopic procedures.

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