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# Unimuscular neuromuscular insult of the leg in partial anterior compartment syndrome in a patient with combined fractures

# 多重骨折患者患上局部前腔隙綜合症及單肌神經肌肉創傷

**A complicated case of ipsilateral fractures of the left femur and tibia after a road traffic accident is reported. The patient presented with numbness of the first web of his left foot and contracture of the extensor hallucis longus muscle, with fixed length deformity after intramedullary nailing of the femur and tibia. The extensor digitorum longus and tibialis anterior muscles were spared. Tinel's sign could be elicited at the mid-portion of the anterior compartment of the injured leg. This indicated that the distal half of the anterior tibial nerve (deep peroneal nerve), together with the extensor hallucis muscle of the anterior compartment of the leg, had been damaged. The subsequent management of this patient is described.**

本文報告一宗因交通意外而造成多重骨折的複雜病例。傷者的左股骨和左脛骨同時出現骨折。他左足第一蹼麻木，伸母長肌攣縮，在股骨和脛骨髓內裝釘後呈現固定長度的畸形。趾長伸肌和脛骨前肌並無徵狀。傷腿的前腔隙中部相信出現蒂內爾徵，顯示前脛骨神經（深腓骨神經）末梢的一半，與腿的前腔隙的伸肌均已受損。本文並報告對這名病人的治療。

## Case report

A 22-year-old male lorry driver sustained a closed transverse fracture of the left femur and a minimally displaced left tibial shaft fracture in a road traffic accident. On admission, his blood pressure was 110/70 mm Hg. Circulation and sensation in the injured limb were normal. Emergency surgery of closed reduction and reamed intramedullary locking nailing of the femur and tibia was performed using general anaesthesia. Postoperatively, the patient had only mild wound pain. Neither postoperative patient-controlled analgesia nor narcotic analgesics were given. Slightly diminished pinprick sensation of the first web of the left leg was noted approximately 24 hours after the operation, without signs of compartment syndrome. The patient was able to move all his toes. Neuropraxia of the anterior tibial nerve was suspected. Partial weight-bearing ambulation and mobilisation exercises were permitted on the second day following surgery.

Progress was satisfactory and out-patient physiotherapy was offered. The sensation loss noted at the first web of the left leg persisted, however. Ten weeks after surgery, the patient developed an abnormal dorsiflexed posture of the left big toe, affecting shoe-wear, walking, and stair climbing. A fixed length deformity of the extensor hallucis longus (EHL) muscle was diagnosed. The dorsiflexed big toe could be exaggerated with active plantar-flexion of the ankle (Fig 1a) but was minimised with dorsiflexion of the ankle (Fig 1b). No active extension (dorsiflexion) of the left big toe could be elicited. Tinel's sign was present in the mid-portion of the leg in the anterior compartment, radiating to the first web.

Conservative treatment with stretching of the EHL muscle and wide toe-box footwear was advised. However, the dorsiflexed big toe hampered the patient's

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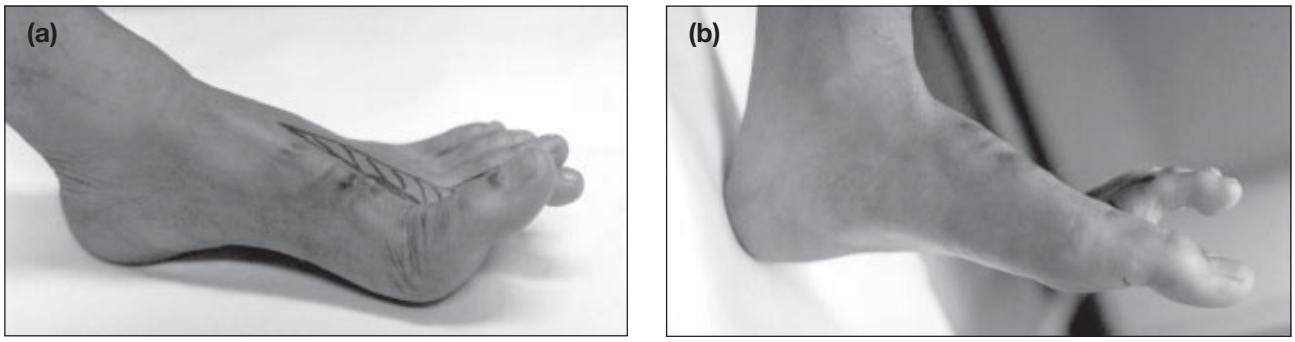


**Fig 1. Contracture of the extensor hallucis longus muscle. (a) This was exaggerated with the ankle in plantar flexion; (b) amelioration occurred with the ankle in dorsiflexion**
The shaded area represents the area of sensation loss

activities and prevented his return to work. Removal of the intramedullary nail, and EHL tendon lengthening were performed 11 months after the first operation. The initial result was good but the big toe gradually returned to the pathological posture after 3 months. The sensation loss persisted without any improvement.

Tendon transfer was performed 18 months after the injury. Tenotomy of the EHL at the mid-tarsal level and of the long toe extensor tendon (extensor digitorum communis, EDC) of the second toe at the metatarsal level was completed, together with tendon transfer by suturing the proximal stump of the EDC of the second toe to the distal stump of the EHL. The distal stump of the EDC to the second toe was sutured to the third toe long extensor tendon.[1] Functional recovery was excellent. Magnetic resonance imaging demonstrated atrophy and fibrotic change of the EHL muscle of the injured left leg (Fig 2). The tibialis anterior and extensor digitorum longus (EDL) muscles were spared. The muscles of the other compartments were normal.

## Discussion

This patient had a delayed form of neuromuscular insult involving the anterior tibial nerve and EHL muscle. The other two muscles, the tibialis anterior and EDL, were spared. The peroneus tertius muscle was flaccid because of denervation from the injury to the anterior tibial nerve. These clinical signs were absent before the intramedullary nailing operation. The sensation loss developed immediately after surgery, whereas the muscular insult presented as progressive fibrosis and contracture.

Similar case reports could not be identified in the literature. Patients with anterior tibial compartment syndrome were reported as presenting with classical, unremitting, burning pain.[2] In these patients, all the muscles of the anterior compartment were weak. Painful passive stretching of the toe extensors was diagnostic, with some patients developing permanent weakness of dorsiflexion at the ankle joint and complete foot drop.

Direct injury during the accident was an unlikely cause of the disability noted in this patient, since neurological findings were normal before the operation. The insult probably resulted from surgery, possibly relating to the reaming of the femur and tibia, traumatic oedema of the muscle, or subperiosteal haematoma collection or other local compression at the site of the EHL muscle and nerve.[3-5] Tinel's sign was present in the middle of the anterior compartment of the leg, pinpointing the location of the insult. Magnetic resonance imaging of the leg showed a hypointense signal, consistent with fibrosis of the EHL muscle without involvement of the other two muscles of the anterior compartment. The EHL muscle, originating from the middle portion of the anterior compartment, corresponded to the site of detection of Tinel's sign. The muscle bulk of the tibialis anterior and EDL muscles located in the proximal half of the leg had decreased and they had become tendinous in the distal part. The tendinous portion of these muscles, together with the lateral surface of the tibia and interosseous membrane, formed a fibro-osseous space for the EHL muscle and the distal portion of the anterior tibial nerve. This was the basis of the muscular involvement in this patient.

Ruland et al[6] demonstrated the flexor digitorum longus to have an extensive fibular origin, completely covering the tibialis posterior muscle and forming a myotendinous fifth compartment of the leg in one of his cadaver dissections. The only muscle in this compartment was the tibialis posterior muscle. This description provides the anatomical basis for the 'unimuscular' type of compartment syndrome.

In this patient, progressive fibrosis and contracture of the EHL muscle suggested that the insult to the muscle was due to ischaemia rather than denervation of the distal half of the anterior tibial nerve. Denervation usually results in a flaccid and atrophic muscle with foot and toe drop. The pathogenesis of the muscle contracture includes prolonged ischaemia, myonecrosis, fibroblastic proliferation, contraction of the cicatrix, and myotendinous adhesion formation.[7] Ischaemia in the fibro-osseous space of the EHL muscle was likely to be the pathogenesis for the unusual neuromuscular lesion seen. A case of lower leg compartment syndrome resulting from femoral intramedullary nailing has been reported.[8] However, it is unclear whether the reaming of the femur contributed to the disability seen in the present patient. Some authors have documented rising

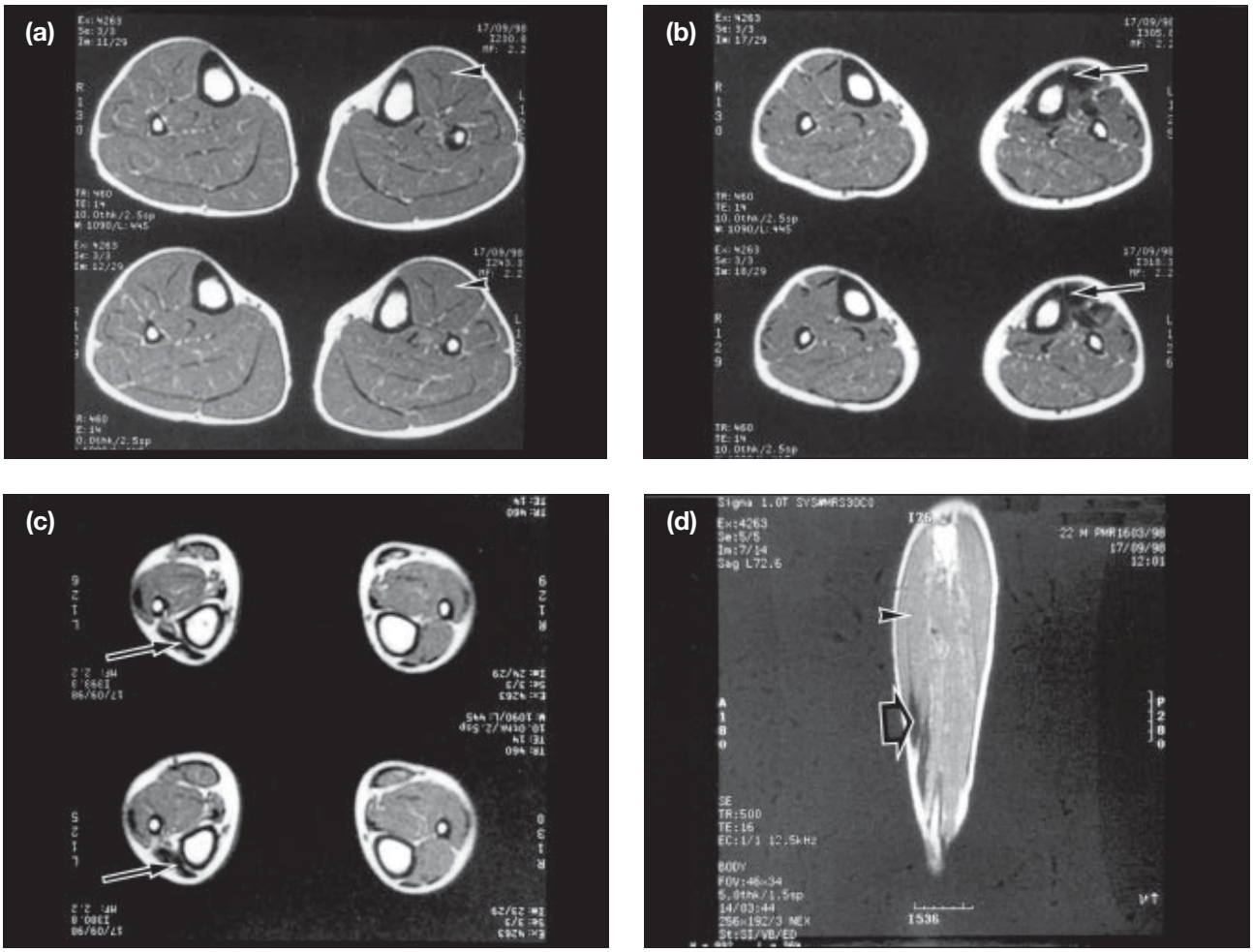


**Fig 2. Magnetic resonance imaging scans of transverse sections of the left leg showing the normal tibialis anterior and extensor digitorum muscles (arrowheads), and the fibrotic extensor hallucis longus muscle (arrows); (a) upper section; (b) middle section; (c) lower section; and (d) the saggital image confirmed the fibrotic extensor hallucis longus muscle (box arrow)**

compartment pressure during reaming.[9] The compartment pressures of the anterior compartment and deep posterior compartment are thought to be the highest of all the compartments.

This case suggests some possible actions for the prevention of this uncommon neuromuscular complication. Unreamed nailing is considered safe without monitoring compartment pressure during the operation.[10] For ipsilateral fractures of the femur and tibia, the additive effect of reaming of the femur and tibia could perhaps be avoided. Close monitoring of the neurological state in the postoperative phase is of paramount importance. Early identification of diminished sensation of the first web, and pain on passive stretching of the EHL tendon suggests the diagnosis. Measurement of the interstitial pressure of the specific compartment at the distal half of the leg may be useful. Probing of the upper anterior compartment in the tibialis anterior muscle of the proximal half of the leg proved misleading in this patient. A differential painful response on stretching of the EHL muscle and other toe extensors should lead to a high index of suspicion for the condition, even when the pain on stretching the big toe is mild. Surgical decompression may be needed for selected patients.

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