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ABSTRACT

A 23-year-old male British soldier developed a progressive sensory loss and weakness in his right arm during a 12 km training run with a load of approximately 70 kg. There was no recovery of his symptoms within 3 months and both MRI and USS did not demonstrate a site of compression within the brachial plexus. An infraclavicular brachial plexus exploration was performed 11 months after injury that indicated an ischaemic neuropathy with post-injury fibrosis. Injuries of the brachial plexus secondary to carrying a heavy backpack during prolonged periods of exercise are rare, particularly in the infraclavicular region. Cases such as this highlight that training regimens within the military population should be appraised due to the risk of similar injuries occurring.

Key messages

- ▶ Brachial plexus injuries secondary to carrying a heavy backpack are rare.
- ▶ Patients usually make a full recovery.
- ▶ This article highlights the importance of reviewing both military training regimes and backpack design to minimise the risk of such injuries occurring.

INTRODUCTION

Brachial plexus injuries secondary to backpack usage are unusual and are most frequently described in the military population. Patients can present with a combination of motor and sensory symptoms; however, sensory deficits are less common. They usually make a full recovery and early diagnosis seems to help. We present an unusual case of brachial plexus palsy following backpack usage and discuss the potential implications for military training.

CASE REPORT

A 23-year-old male British soldier developed progressive sensory loss and weakness in his right arm during a 12 km training run with a load of approximately 70 kg (50 kg bergan, 10 kg webbing, 5 kg helmet and body armour, 5 kg weapon).

There was no spontaneous recovery and he was referred for specialist assessment 1 month later. He reported mild pain in the anterior shoulder. On examination, there was mild restriction in passive external rotation of the shoulder but no visible swelling or bruising. Distal pulses were present without venous engorgement. Neurological examination revealed no function in the musculocutaneous or median nerves or the posterior cord of the brachial plexus below the branch to the long head to triceps, but medial cord function was preserved. There was a strongly positive Tinel–Hoffman sign in the infraclavicular area extending over coracobrachialis to the upper arm and features of autonomic dysfunction in the median and radial innervated territories of the hand.

The persistent dense neurological deficit with autonomic dysfunction implied a significant degenerative nerve lesion affecting the infraclavicular plexus but sparing the medial cord. The provisional diagnosis was ischaemic neuropathy secondary to compression but further investigations were arranged to assess for evidence of venous thrombosis, haematoma or fibrosis of the pectoralis minor secondary to a compartment syndrome.

An MRI scan showed oedema around the anterior shoulder and an USS displayed prominence of the fascicular pattern of the brachial plexus with good glide of the plexus on neck movements and no site of compression.

He was managed with physiotherapy to maintain passive upper limb movements and clinical follow-up to monitor an advancing Tinel–Hoffman sign which is seen in cases of axonal regeneration. Biceps contraction started at 3 months and by 6 months there was recovery in all muscles although there was still loss of bulk and weakness compared with the contralateral limb. The area of tenderness over the infraclavicular fossa remained with a moderate Tinel–Hoffman sign radiating to the forearm over coracobrachialis.

Despite shoulder retraction and neural gliding exercises, he remained unable to undertake military training and attempting to carry even light backpacks caused a return of dysaesthesia and weakness to the arm within a few minutes.

In view of the continuing functional impairment, the infraclavicular brachial plexus was explored at 11 months after injury. The pectoralis minor was thickened but of normal texture with no evidence of fibrotic contracture. The tendon was divided and the sheath around the brachial plexus was found to be thickened with a fascial band causing some compression of the musculocutaneous nerve under coracobrachialis. The lateral and medial cords along with the median nerve were all normal with no scarring or neuroma. The axillary artery and veins were normal. These findings were suggestive of an ischaemic neuropathy with post-injury fibrosis. The ischaemia itself would have been caused by prolonged compression along with downward traction on the upper roots and compression in the retroclavicular space due to pressure from the shoulder strap of the soldier's rucksack.

By 5 months post-operatively, he had a full range of movement in his upper limb. Power was normal except 4/5 power in his biceps and finger flexors; there was some reduced sensation over the ulnar and median nerve distribution. He still presented with dysaesthesia in his right arm on exercise and carrying loads.

DISCUSSION

Brachial plexus injury secondary to backpack usage is unusual and has mostly been described in the military population. It has previously been described as trekker's palsy. It has been proposed that due to more ergonomically designed backpacks, the rate of plexus injury secondary to backpacks has decreased.[1] However, the load carried by military personnel has increased significantly since the 18th century where estimated loads were 15 kg.[2] It is not only backpack usage within the military population that contributes to brachial plexus injuries. Bhatt[3] described two cases of brachial plexus lesions secondary to body armour weighing approximately 5 kg.

In the work by Mäkelä *et al*,[4] the incidence of brachial plexus injuries secondary to backpack usage within the Finnish army was 53.7 per 100 000 per year. They found that the long thoracic nerve and the axillary nerve were most commonly affected and interestingly none of their patients had symptoms consistent with an infraclavicular brachial plexus injury; 7% of their sample who did suffer from brachial plexus injuries also had hereditary neuropathy with susceptibility to pressure palsies. Generally, this patient subset developed symptoms with lighter loads.

Further work on brachial plexus injuries in the context of prolonged backpack usage within the Finnish military by Nylund *et al*[5] displayed a full recovery in 80% of patients after 9 months and a full return to normal activity in 95% of patients. They concluded that initial electromyography was useful in diagnosis, but was not a good prognostic tool. Their recommendations included the avoidance of using backpacks above 40 kg in weight. Body structure and physical fitness were not indicators of predisposition to brachial plexus injury.

All patients in the case series of Nylund *et al* were managed with physiotherapy; therefore, early diagnosis and intervention may accelerate recovery. However, the authors cannot find any literature investigating a relationship between the time to diagnosis and outcomes in trekker's palsy.

Utilisation of imaging and electrodiagnostic tools are important in the management of brachial plexus injuries. MRI scans are considered the best modality for imaging infraclavicular and peripheral lesions.[6] MRI is also the preferred modality for the assessment of neoplasia and non-traumatic brachial plexus lesions. However, in our case, MRI did not assist in diagnosing the cause of our patient's symptoms.

Ultrasound can demonstrate lesions such as axonal swelling, neuroma formation and fascicular disruption. A further advantage is that the dynamic nature of USS allows nerve gliding to be assessed, which has been found to have high correlations with intra-operative findings of brachial plexus and peripheral nerve lesions.[7 8]

Neurophysiological testing provides a role in localising and indicating the severity of brachial plexus lesions. As in our case, studies should be performed after 4–6 weeks to minimise the risk of false findings due to Wallerian degeneration. Follow-up testing is often indicated to assess recovery from injury; however, in this case it was not done.

Repeated systematic clinical examination is essential for accurate diagnosis in peripheral nerve injuries. The Tinel–Hoffman sign is demonstrated by tapping along the course of an injured peripheral nerve from distal to proximal and at the site of axonal disruption the patient perceives pain in the cutaneous territory of the nerve involved. In lower grade nerve injuries, the recovery may be monitored by distal progression of the Tinel sign.[9] Static Tinel is a sign of more severe nerve injury or persistent compression that warrants exploration and decompression. Jules Tinel first described his eponymous test in 1915 when assessing injured soldiers from World War I; he applied it to any nerve and in our case it identified the affected area accurately. Paul Hoffman, a German neurophysiologist, had described the same phenomenon as Tinel in the German medical literature 3 months previously, and so although rarely credited for it, the Tinel–Hoffman sign is the correct nomenclature.[10]

Brachial plexus injuries tend to be due to two principle mechanisms: traction and direct compression that can occur in isolation or together.[11] The majority of the literature describes injuries secondary to traction usually in the context of polytrauma. Downward traction will generally result in lesions of the upper cervical nerve roots compared with upward traction resulting in injury to the lower cervical nerve roots. However, in this case, the mechanism was downwards and posterior traction on the lateral clavicle and shoulder resulting in compression of the infraclavicular plexus.

Compressive plexopathies generally do not present in the classical patterns of Erb's and Klumpke's palsies as with traction injuries. Typically in a trekker's palsy, patients present with initial paraesthesia in the arm during the march. Motor weakness mainly affecting the shoulder girdle and elbow flexors are key features. Sensory disturbances are less common and pain is usually associated with movement after the onset of muscle atrophy.[4]

However, a case by De Luigi *et al*[1] describes a soldier carrying approximately 50 kg of equipment presenting with normal power but decreased sensation in the arm consistent with a neuropathy of the right lateral antebrachial cutaneous nerve.

The use of hip belts reduces pressure on the shoulder area and the ideal site of load placement for a rucksack can change depending upon the terrain; lower load placement is preferred for uneven ground with higher placement for more even terrain.[2] The use of framed packs can further transfer weight from the shoulders to the hips.[12] The use of rucksack frames has been quoted as reducing the risk of compression neuropathy from 1.17/1000 to 0.157/1000.[13]

CONCLUSIONS

Injuries of the brachial plexus secondary to carrying a heavy backpack during prolonged periods of exercise are rare and patients usually make a full recovery. In plexus injuries secondary to backpack usage, compression appears to be the principle mechanism. However, in general, traction is the commonest cause of brachial plexus injuries; combined injuries can occur. Infraclavicular compression and irritation are particularly unusual, possibly attributable to muscular hypertrophy of pectoralis minor.

Cases such as this highlight both the need to review military training regimens and the importance of rucksack design in order to minimise risk of these injuries. Increased awareness of this injury pattern by military doctors, physiotherapists and physical trainers could minimise any delay between injury and assessment.

Contributors RM is the principle contributor with YS and CS as editors and DP as senior author.

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REFERENCES

1 De Luigi AJ, Pasquina P, Dahl E. Rucksack induced plexopathy mimicking a lateral antebrachial cutaneous neuropathy. *Am J Phys Med Rehabil* 2008;87:773–5.
2 Knappik JJ, Reynolds KL, Harman E. Soldier load carriage: historical, physiological, biomechanical, and medical aspects. *Mil Med* 2004;169:45–6.
3 Bhatt BM. 'Top Cover Neuropathy'—Transient brachial plexopathy due to body armour. *JRAMC* 1990;136:53–4.
4 Mäkelä JP, Ramstad R, Mattila V, *et al*. Brachial plexus lesions after backpack carriage in young adults. *Clin Orthop Relat Res* 2006;452:205–9.
5 Nylund T, Mattila VM, Salmi T, *et al*. Recovery of brachial plexus lesions resulting from heavy backpack use: a follow-up case series. *BMC Musculoskelet Disord* 2011;12:62.
6 O'Shea K, Feinberg JH, Wolfe SW. Imaging and electrodiagnostic work up of acute adult brachial plexus injuries. *J Hand Surg Eur Vol* 2011;36E:747–59.
7 Toros T, Karabay N, Ozaksar K, *et al*. Evaluation of peripheral nerves of the upper limb with ultrasonography: a comparison of ultrasonographic examination and the intra-operative findings. *J Bone Joint Surg Br Vol* 2009;91:762–5.
8 Chen DZ, Cong R, Zheng MJ, *et al*. Differential diagnosis between pre and postganglionic adult traumatic brachial plexus lesions by ultrasonography. *Ultrasound Med Biol* 2011;37:1196–203.
9 Valdes K, LaStayo P. The value of provocative tests for the wrist and elbow: a literature review. *J Hand Ther* 2013;26:32–42; quiz 43.
10 Hoffmann P, Buck-Gramcko D, Lubahn JD . The Hoffmann-Tinel sign. 1915. *J Hand Surg Br* 1993;18:800–5.
11 Desai DC, Uribe A, Lachman T. Brachial plexus injury due to compression: an alternate mechanism of injury: case report and review of the literature. *Am Surg* 1997;63:487.
12 Knappik J, Harman E, Reynolds K. Load carrying using packs: a review of the physiological, biomechanical and medical aspects. *Appl Ergon* 1996;27:207–16.
13 Bessen R, Belcher V, Frankin R. Rucksack paralysis with and without rucksack frames. *Mil Med* 1987;152:372–57.