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Evaluation of whiplash injuries by technetium 99^{m} isotope scanning

D. BARTON, M. ALLEN, D. FINLAY & I. BELTON
Accident & Emergency Department, Leicester Royal Infirmary, Leicester

SUMMARY

Despite the frequency with which whiplash injuries present to accident and emergency (A&E) departments, there lacks an objective investigation to define the severity of the initial injury or the morbidity that may ensue. Following reports on the effectiveness of isotope bone scanning for soft tissue and ligament injuries a study was undertaken of isotope scanning of whiplash injuries. The objectives of the study were to isolate the anatomic site of the injury and to quantify the severity of the injury with relation to the concentration of isotope uptake and subsequent morbidity.

INTRODUCTION

The term whiplash injury has become synonymous with the hyperextension, hyperflexion injury of the cervical spine. The advent of seat-belt legislation has increased the incidence of this type of injury (Allen *et al.*, 1985; Rutherford *et al.*, 1985). The exact aetiology of the condition is unknown but many theories exist which include overstretching of soft tissues, intervertebral joints, nerve roots and peripheral nerves in the posterior cervical and lumbar spine. Radiological findings offer no characteristic or pathognomic lesion: prognostic indicators as exist are non specific.

Reports on technetium 99m ($^{99}Tc^{m}$) isotope scanning outline the effectiveness of this investigation in demonstrating periosteal irritation associated with ligamentous avulsion and muscle injury (Rosenthal *et al.*, 1976; Fogelman, 1987; Maurice *et al.*, 1987).

Correspondence: Mr D. Barton, Accident & Emergency Department, James Connolly Memorial Hospital, Blanchardstown, Dublin 15.

PATIENTS AND METHODS

Patients presenting to the A&E department with 'whiplash' injuries were enrolled consecutively into the study. Following initial assessment and examination, radiographs of the cervical spine which included antero-posterior, lateral and open mouth odontoid peg view were performed. The patients were fitted with a soft collar and prescribed non-steroidal anti-inflammatory agents. Two days later they were reviewed by one of the authors (DB). Details of the accident were documented. The pattern of symptoms immediately after the accident and over the intervening 2 days were recorded. The patients were then examined with particular reference to areas of tenderness of the cervical spine and muscle groups. Their range of neck movements were recorded with a goniometer. The normal combined range of movement of the cervical spine of flexion, extension, left and right lateral flexion and rotation was accepted as 380° (McRae, 1983). The sum of the reduced range of movements was expressed as a percentage of this figure. An isotope bone scan was performed on the same day by injection of an intravenous bolus dose of 400 MBq of $^{99}Tc^{M}$ methylene diphosphonate. Dynamic (20 × 4 second frame) and blood pool posterior images were obtained 2 min after injection. Posterior and lateral images with the neck in flexion were obtained at 2–4 h.

The patients were advised to decrease their use of the collar over the ensuing 7 days and requested to attend for review at 2 months.

RESULTS

Twenty patients were enrolled into the study. The male to female ratio was 1:1.2. The mean age was 34.15 years with a range of 18–53 years. With regard to position in the vehicle, 13 patients were drivers and seven were front seat passengers. Nine were in stationary vehicles.

Onset of symptoms

Eight patients described the onset of symptoms as immediate, of these four were aware that the accident was about to happen, i.e. they were involved in frontal collisions. Five reported symptoms occurring within 1 h of injury, four less than 4 h and three, 1 day later.

Symptoms

The range of symptoms described are illustrated in Table 1. All complained of neck pain with a large proportion stating they had interscapular back pain and headaches. Four patients described post-traumatic amnesia.

Examination

Tenderness of the cervical spine was elicited in 18 patients, and of muscle groups

Table 1. Symptoms

Symptom	Number
Neck pain	20
Interscapular back pain	14
Headaches	13
Radiating pain	12
Paraesthesiae	6
Post traumatic amnesia	4
Loss of consciousness	2

either paraspinal, sternomastoid, trapezius or latissimus dorsi in 19 patients. With regard to neurological assessment 13 patients had normal power and seven diminished power of the upper limbs. Sensation was normal in nineteen and decreased in one following a C6 distribution. All 20 patients had normal reflexes. The range of cervical spine movement was decreased in all patients. The mean percentage reduction of cervical spine movement was 46.53%, with a range of 22.3–71%.

Radiology

The films were reported on by one radiologist (DF) as normal in nine patients, six demonstrating a loss of lordosis and five revealing degenerative changes. One patient had both loss of lordosis and degenerative disease present on the radiographs.

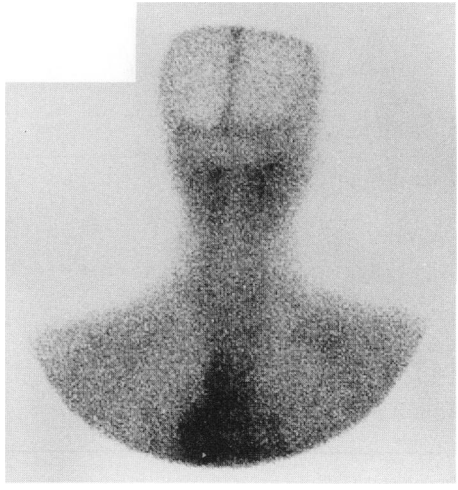

Fig. 1. Photograph of normal scan — dynamic phase.

Isotope scans

The isotope scans were reported as normal in both the dynamic blood pool (Fig. 1) and static (Fig. 2) phase in nineteen patients with one patient demonstrating changes consistent with degenerative disease. (Fig. 3).

There was no correlation between the symptoms as outlined in Table 1 or signs on examination and the isotope scan results. This was confirmed applying Fishers exact test in that no association was found.

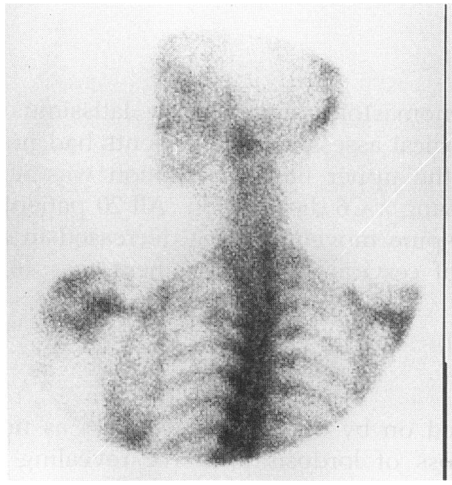

Fig. 2. Photograph of normal scan — static phase.

Fig. 3. Photograph of abnormal scan — static phase.

Review

Four patients were lost to follow up. Of the remaining 16 patients, 14 were still symptomatic and 11 complained of neck pain. Twelve patients felt that they had improved. Two patients considered their symptoms to be the same and two reported a deterioration. Both of the latter patients had degenerative changes on their initial radiographs.

DISCUSSION

Despite the frequency with which the 'whiplash' type injury or dynamic injury of the cervical spine presents to the A&E department little is known of its pathology.

Theories exist which include overstretching of soft tissues, intervertebral joints, nerve roots and peripheral nerves in the posterior cervical and lumbar spine. MacNab (1964) performed experiments on animals whereby anaesthetized monkeys were dropped down a vertical runway. It was found that the following lesions were consistently produced: muscle injuries ranging from minor sternomastoid tears to partial avulsion of longus colli, haemorrhages of the muscle layer of the oesophagus, and tearing of the anterior longitudinal ligament with separation of the disc from the associated vertebrae.

Prognostic indicators as exist are non-specific and include the presence of objective neurological signs, stiffness of the neck, muscle spasm and pre-existing degenerative spondylosis (Norris & Watt, 1983), reversal of cervical lordosis, use of a collar for more than 12 weeks and resumption of physiotherapy (Hohl, 1974). Reports on $^{99}Tc^{m}$ scanning outline the effectiveness of this investigation in demonstrating periosteal irritation associated with ligamentous avulsion and muscle injury. Soft tissue trauma even in the absence of bony injury can be revealed by increased activity on a bone scan (Maurice *et al.*, 1987). If performed within a few days of the onset of pain nuclear medicine studies utilizing bone seeking pharmaceuticals can be used to differentiate between acute muscle injury, skeletal injury, periosteal injury or stress fracture, or an abnormality which is entirely associated with a joint or connective tissue (Fogelman, 1987).

This study failed to demonstrate a correlation between symptoms or signs of dynamic hyperflexion hyperextension injuries of the cervical spine and findings on isotope scans. This invasive investigation does not play a role in the further evaluation of these injuries at the time interval specified in this study.

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