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DORSAL WRIST JOINT PAIN IN TETRAPLEGIC PATIENTS DURING AND AFTER REHABILITATION

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In a study of 42 tetraplegic patients, physiological, neurological, electrophysiological and radiological examinations were made in 11 patients with complete tetraplegia who had wrist pain after rehabilitation. Pain relief produced by a selective, posterior interosseous nerve lidocaine block indicated distal posterior interosseous nerve syndrome. This syndrome can sometimes be treated conservatively, but surgical excision was required after nerve scarification. Repetitive dorsiflexion, as in wheelchair handling, transfer and tenodesis-like movement, compresses the distal posterior interosseous nerve in some tetraplegic patients. Moreover, weakness of the wrist joint stabilizing muscles is likely to contribute to an increased weight load on the wrist joints. The aetiology of wrist pain in tetraplegia should be considered when there is carpal tunnel syndrome, Wartenberg syndrome, Kienböck syndrome or distal posterior interosseous nerve syndrome. The causes need to be adequately treated to reduce the negative impact of the resultant pain on carrying out the activities of daily life.

Key words: tetraplegia, wrist joint, pain, rehabilitation.

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INTRODUCTION

Joint pain in the upper extremities is frequent in patients with spinal cord injury (SCI) (1–3). Nichols et al. (1) reported that 52% of patients with SCI studied had shoulder pain. Bayley et al. (2) found a 30% incidence of persistent, chronic shoulder pain during transfers in a population of 94 patients with complete paraplegia. Upper extremity joint pain obstructs the activities of daily life (ADL) of SCI patients. Moreover, paraplegic patients who are highly active tend to have upper extremity joint pain (3).

On the other hand, some tetraplegic patients complain of wrist joint pain during medical rehabilitation, in particular wrist joint pain on the dorsal side of the joint. Wrist joint pain experienced during the medical rehabilitation period disturbs the progress of rehabilitation and the patients' ADL, but there have been few reports on wrist joint pain in patients with complete tetraplegia.

The aim of the study was to investigate why wrist joint pain, on the dorsal side in particular, sometimes occurs in tetraplegic patients during the early stage of medical rehabilitation after SCI. The cause of wrist joint pain was investigated by means of physiological, electrophysiological and radiological examinations made on patients with complete tetraplegia. We discuss the specific causes of their wrist joint pain and the treatment to be used to alleviate such pain.

MATERIAL AND METHODS

The SCI patients had been receiving or had just completed medical rehabilitation at a rehabilitation hospital following SCI and were seeing a doctor regularly after discharge or, were still inpatients in the rehabilitation hospital from January 1996 to August 1999. For inclusion in this study the SCI subjects had to fulfil the following criteria: patients with complete tetraplegia who could propel a hand-operated wheelchair and perform push-up movements as the main means of transfer. The completeness of injury was determined from results of an American Spinal Injury Association (ASIA) examination. The accidents in which their spinal cords were injured had occurred within 18 months prior to our examination. Forty-two SCI patients were matched to the inclusion criteria (age range 18–56 years; mean age 34 years; 31 men, 11 women).

Physiological and neurological examinations were performed according to ASIA neurological criteria to determine sensory/motor/neurological levels, in order to generate scores to characterize sensory/motor functioning. We asked whether the patients suffered from wrist joint pain at rest and/or during movement (transfer, push-up movement and propelling a wheelchair).

The painful and tender areas of the wrist joint of those who experienced limited wrist joint pain were investigated and the presence of masses or ganglions at the wrist joint checked.

Electrophysiological and radiological examinations were performed on tetraplegic patients who had wrist joint pain. (Two patients with carpal tunnel syndrome, two with Wartenburg syndrome, one with osteoarthritic change and one with Kienböck syndrome; in the rest of these patients the diagnoses were difficult by electrophysiological and radiological examinations).

A "Counter Point™" EMG apparatus equipped with surface electrodes was used for electrophysiological examinations. Radial nerve sensory conduction velocity was examined in an antidromic sensory nerve conduction study. The disk electrode (G1) was placed over the first web space, the reference electrode (G2) near the first dorsal interosseous. The radial sensory nerve became readily accessible to percutaneous stimulation at the lateral edge of the radius in the distal forearm 10–14 cm proximal to the recording electrodes. Median and ulnar nerve sensory conduction velocities were determined in an antidromic sensory nerve conduction study done at the index or little finger. Median and ulnar motor conduction velocities at the forearm were examined by the usual electromyographic methods.

X-ray photographs of the wrist joints and hands were examined. Patients with dorsal wrist joint pain underwent an MRI examination of their wrist joints.

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Table I. *Neurological level, period after injury, electrophysiological examination, radiological examination and the effect of DPIN block for 11 tetraplegic patients with wrist joint pain*

Sex	Age (years)	Neurological level	Period after injury (months)	Median nerve		Rad n sens	X-P	DPIN block
				mot	sens			
M	35	C6	17	nl	nl	nl	nl	Effective
F	23	C6	8	nl	nl	nl	nl	Effective
M	18	C6	9	nl	nl	nl	Kien	Not performed
M	49	C6	7	del	del	no ev	OA	No effect
M	48	C8	15	del	del	nl	nl	Not performed
F	22	C6	11	nl	nl	nl	nl	No effect
F	22	C7	10	nl	nl	del	nl	Not performed
M	27	C6	14	nl	nl	nl	nl	Effective
M	19	C6	10	nl	nl	nl	nl	No effect
M	27	C6	8	nl	nl	nl	nl	No effect
M	28	C6	14	nl	nl	nl	nl	Effective

Mot = motor nerve distal latency, sens = sensory nerve distal latency, Rad n = radial nerve, nl = normal, no ev = no evoked response, del = delayed latency, OA = osteoarthritis, Kien = Kienbock disease, DPIN = distal posterior interosseous nerve.

RESULTS

Wrist joint pain was present in 11 of 42 complete tetraplegic patients. As to neurological levels, 9 patients were C6, 1 was C7 and 1 was C8. Those patients were given electrophysiological and radiological examinations (Table I). Physical examinations detected no palpable masses or ganglions at the wrist joint. No snapping or clicking was elicited. There was no special relationship between severity of spasticity and presence of wrist joint pain. Median sensory nerve conduction velocity and median motor nerve distal latency were delayed in 2 (motor distal latency was between 4.5 and 5.5 ms for 7 cm distance: sensory distal latency was between 3.5 and 4.0 ms for 14 cm distance), whereas median motor nerve conduction velocity between the wrist and elbow was normal in all the patients. One had abnormal ulnar nerve sensory and motor distal latencies with a delay in median nerve distal latency, but all 11 had normal conduction velocity at the forearm. As distal latency delay was not very severe, conservative therapy was used. Radial sensory nerve conduction velocity at the wrist joint was delayed in 2 patients, for whom the diagnosis was Wartenberg syndrome, and may have contributed to their radial dorsal joint wrist pain.

Fig. 1. A 49-year-old patient with C6 level revealed osteoarthritis on X-ray photograph in bilateral wrist joints.

The X-ray photograph of a 49-year-old patient with C6 level revealed osteoarthritis in bilateral wrist joints (Fig. 1). An electrophysiological examination also found carpal tunnel and Wartenberg syndromes. His pain was lessened by intermittent rest and administration of an analgesic drug. X-ray and MRI detected Kienböck disease in another young, C6 level tetraplegic patient (Fig. 2). His Kienböck disease stage was Lichtman stage (4) II level. Because it was not so severe, conservative therapy was applied in this case. He was prohibited from self-propelling his wheelchair and self-transfer, and at night for 6 weeks a splint was placed on his wrist joint at neutral position after which he no longer complained of wrist joint pain. After the conservative therapy he could perform usual medical rehabilitation and had no recurrent of Kienböck disease. There was no evidence of scapholunate dissociation, or fracture in any of the patients.

Four patients in particular complained of pain in the dorsal portion of their wrist joints. All had fourth compartment tenderness as well as dorsal wrist pain related at onset to repetitive dorsiflexion maneuvers. Diagnosis based only on electrophysiological and radiological examination results was difficult in their cases. Their dorsal wrist pain was relieved by selective lidocaine block of the terminal branch of the posterior interosseous nerve at the wrist joint. Immediate elimination of

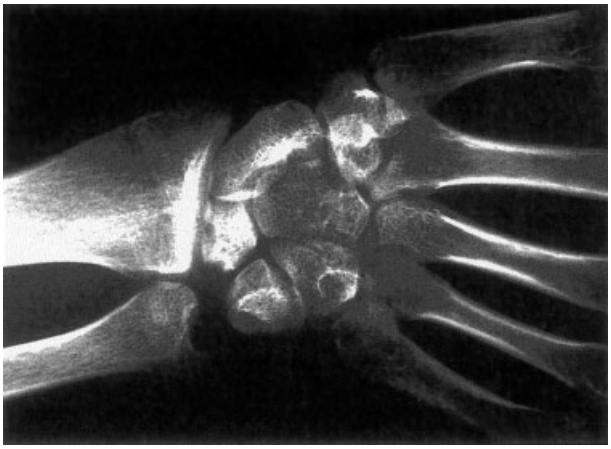

Fig. 2. X-ray photograph showing Kienbock disease in a C6 level young tetraplegic patient.

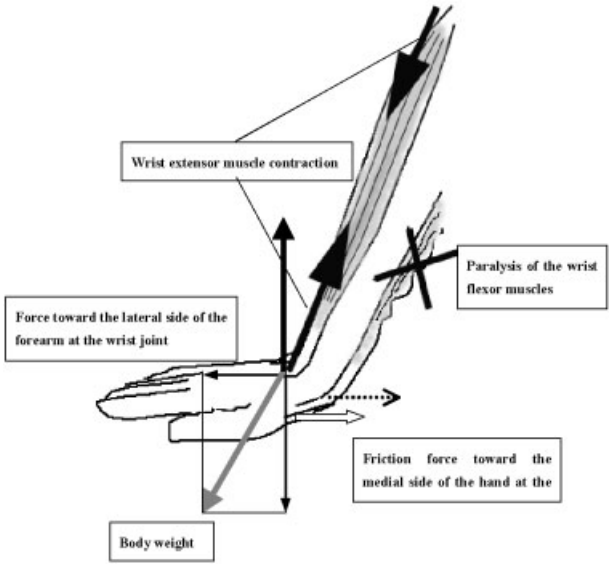

Fig. 3. C6 level tetraplegia patients have only wrist extensor muscle activity, with paralysis of the wrist flexor muscles. Because of forearm muscle imbalance, body weight load tends to be borne on the wrist joints and there is joint instability during pushing up movements.

discomfort in the wrist joint after injection indicated that the distal posterior interosseous nerve was the pain transmitter. Their dorsal wrist pain therefore was diagnosed as distal posterior interosseous nerve syndrome. Three patients, who obtained excellent pain relief from a one-time nerve block, needed non-surgical pain management, which consisted of splinting, analgesics, repetitive lidocaine blocks and time off from medical rehabilitation. For these patients the presumptive diagnosis was distal posterior interosseous nerve syndrome, but lack of pathological confirmation made the diagnosis speculative. Another C6 tetraplegic woman with distal posterior interosseous nerve syndrome had recurrent dorsal wrist pain in spite of conservative therapy like repetitive lidocaine blocks. A partial dorsal denervation operation was performed for her, after which pain relief was obtained. Her posterior interosseous nerve was enlarged where it arborized at the wrist joint. When a lidocaine block produced no pain relief, distal posterior interosseous nerve syndrome was not diagnosed. An alternative explanation was sought to explain the patients' symptoms. Three patients who complained of wrist joint pain showed no radiological or electrophysiological change and where without a specific physical examination symptom. A lidocaine block at the wrist joint did not give pain relief. There was no adequate explanation for their wrist joint pain.

DISCUSSION

The prevalence of wrist joint pain in patients with complete tetraplegia after comprehensive rehabilitation has not been thoroughly studied. Joint pain in tetraplegia is generally dependent on the injury level. Sie et al. (3) found shoulder pain to be the type of pain most commonly reported by tetraplegic patients. Subarrao et al. (5), Silfverskiold & Waters (6) and Sie et al. (3) noted higher incidences of wrist and shoulder pain less than 1 year after injury and after more than 15 years in tetraplegic patients. Subarrao et al. (5) discussed the acute trauma caused by early pain and the cumulative trauma of late onset pain in the tetraplegic upper extremity joint. About 25% of our complete tetraplegic patients suffered wrist joint pain within 18 months of injury in our study. Of the 11 tetraplegic patients who had wrist joint pain, 1 also complained of shoulder pain and 2 of elbow pain. Of the tetraplegic patients without wrist joint pain, a few complained of elbow and shoulder joint pain during and after rehabilitation. We considered that among complete tetraplegic patients, C6 level will more frequently complain of wrist joint pain than of elbow or shoulder joint pain during or just after medical rehabilitation. The level of the lesion is important factor for joint pain in tetraplegia. C6 level tetraplegia patients have only wrist extensor muscle activities for wrist joint stability due to paralysis of the wrist flexor muscles. We assumed that because of anatomic variations in the wrist dynamics of C6 tetraplegia, body weight load tends to be borne on their wrist joints. Figure 3 suggests that the force toward the lateral side at forearm distal end damages the wrist joint due to the friction force between the hand and the floor toward the medial side during pushing up movements. Repetitive wrist extension for tenodesis-like action, which is needed for grasping in ADL would be also a cause of wrist joint damage in C6 tetraplegia.

For 2 tetraplegic patients a diagnosis of carpal tunnel syndrome was made based on electrophysiological examination results. Although carpal tunnel syndrome is reported to be the main cause of wrist joint or hand pain in paraplegic patients (3), the frequency of carpal tunnel syndrome was not high among the tetraplegic patients we studied. Carpal tunnel syndrome is common in paraplegic patients because they are highly active

Table II. *Causes of dorsal wrist joint pain*

Scaphoid impaction
Dorsal carpal capsulitis
Scapholunate interosseous ligament disruption
Distal posterior interosseous nerve syndrome
Occult dorsal carpal ganglion
Kienböck disease
Tendon synovitis
Wartenberg syndrome

for transfer movement or wheelchair propelling. Tetraplegic patients, however, may have less chance of carpal tunnel syndrome because due to their severe disability they are less active than paraplegic patients. Alijure et al. (7) and Gellman et al. (8) documented an increase in carpal tunnel-related complaints with the time since injury. Because the period after injury in our patients was less than 18 months, carpal tunnel syndrome cases were few. Moreover, as the syndrome was not very severe, conservative therapy could be used. Wartenberg syndrome was diagnosed in 2 patients and carpal tunnel syndrome and wrist joint OA change in 1. Repetitive dorsiflexion of the wrist joint and the wrist joint load during wheelchair propelling may cause Wartenberg syndrome.

Osteoarthritis and Kienböck disease were detected by X-ray and MRI examinations. One middle-aged, C6 level, tetraplegic patient showed osteoarthritic change, which suggests extreme wrist joint load is present in C6 level patients. Such bone changes would contribute to wrist joint overuse in pushing up movements and wheelchair handling.

Most of the tetraplegic patients with dorsal wrist joint pain showed no abnormality in the electrophysiological or X-ray examinations. Some with wrist pain complained in particular of pain on the dorsal side of the wrist joint following medical rehabilitation. Various aetiologies have been considered to cause dorsal wrist joint pain (9) (Table II). We propose that distal posterior interosseous nerve syndrome is another special cause of dorsal wrist joint pain in tetraplegia and that it is distinct from such usual causes as dorsal ganglia, degeneration of the scapholunate ligament and dorsal carpal capsulitis, the causes of which might be dorsal occult ganglion. A clear diagnosis, however, could not be made on the basis of radiological and electrophysiological examination, and more detailed examinations or surgical treatment therefore is needed. Distal posterior interosseous nerve syndrome should be considered when the usual sources of dorsal wrist pain are eliminated by physical, electrophysiological and radiological results. The specific symptoms of distal posterior interosseous nerve syndrome found were point tenderness of the fourth extensor compartment and reproduced pain on extreme wrist extension. When a nerve block produced by a lidocaine injection to the distal posterior interosseous nerve region was effective for ameliorating dorsal wrist pain, distal posterior interosseous nerve syndrome was diagnosed. A site 2-cm proximal to the wrist joint was usually chosen as the injection point in order to avoid injection to the joint itself (10). A nerve block to the distal posterior interosseous nerve is both a therapeutic and diagnostic intervention for this syndrome.

The posterior interosseous nerve is often assumed to receive damage due to wrist joint hyperextension caused by the pushing up movement and wrist joint instability caused by wheelchair handling. Repetitive dorsiflexion movements also would produce mechanical impingement on the sensory branch of the posterior interosseous nerve at the carpus, leading to perineural fibrosis, intraneural fibrosis and microneuromas (10). Usual extension in a normal wrist does not impinge on the distal posterior interosseous nerve, whereas a mobile wrist in combination with a prominent bulbous expansion of the nerve seems to be a predisposition for posterior interosseous nerve syndrome because with perineural fibrosis and hypertrophy, the nerve cannot escape mechanical impingement during wrist extension (11). For tetraplegic patients not yet in the fibrotic stage, a protective splint at a neutral position on the wrist joint or an anesthetic injection should be considered for dorsal wrist joint pain in order to accelerate rehabilitation.

In our study there were some patients for whom no diagnosis of their wrist joint pain could be made by electrophysiological, radiological or other methods, such as a nerve block. Because their wrist pain was not severe, it was ameliorated by analgesics and time off from rehabilitation. Subbarao et al. (5) reported that changes are more pronounced in soft tissues around the wrist joints and that X-rays may not show those changes. Such patients may have soft tissue changes or small occult ganglia at the wrist joint.

There are various causes of wrist joint pain in patients with complete tetraplegia after medical rehabilitation. The aetiology of wrist joint pain should always be taken into account during and after rehabilitation for these patients. When dorsal wrist joint pain occurs in patients with complete tetraplegia during and after rehabilitation, posterior interosseous nerve syndrome should be considered as a special aetiology and a protective splint used or anesthetic drug injection given as soon as possible.

The wrist joint pain should be treated adequately to reduce the negative affect it has on the patients' ability to carry out ADL.

REFERENCES

1. Nichols PJR, Norman PA, Ennis JR. Wheelchair user's shoulder? Shoulder pain in patients with spinal cord lesions. Scand J Rehabil Med 1979; 11: 29–32.
2. Bayley JC, Cochran TP, Sledge CB. The weight-bearing shoulder. The impingement syndrome in paraplegics. J Bone Joint Surg (Am) 1987; 69: 676–678.
3. Sie IH, Waters RL, Adkins RH, Gellman H. Upper extremity pain in the postrehabilitation spinal cord injured patient. Arch Phys Med Rehabil 1992; 73: 44–48.
4. Alexander AH, Lichtman DM. Kienbock's disease. Orthop Clin North Am 1986; 17: 461–472.
5. Subbarao JV, Klopfstein J, Turpin R. Prevalence and impact of wrist and shoulder pain in patients with spinal cord injury. J Spinal Cord Med 1995; 18: 9–13.
6. Silfverskiold J, Waters RL. Shoulder pain and functional disability in spinal cord injury patients. Clin Ortho & Related Res 1991; 272: 14–15.

7. Alijure J, Eltorai I, Bradley WE, Lin JE, Johnson B. Carpal tunnel syndrome in paraplegic patients. Paraplegia 1985; 23: 182–186.
8. Gellman H, Chandler DR, Petrask J, Sie I, Adkins R, Waters RL. Carpal tunnel syndrome in paraplegic patients. J Bone Joint Surg (Am) 1988; 70: 517–519.
9. Steinberg BD, Kleinman WB. Occult scapholunate ganglion: a cause of dorsal radial wrist pain. J Hand Surg 1999; 24A: 225–231.
10. Dellon AL, Baltimore MD. Partial dorsal wrist denervation: resection of the distal posterior interosseous nerve. J Hand Surg 1985; 10A: 527–533.
11. Carr D, Davis P. Distal posterior interosseous nerve syndrome. J Hand Surg 1985; 10A: 873–878.