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Short report

The utility of testing tactile perception of direction of scratch as a sensitive clinical sign of posterior column dysfunction in spinal cord disorders

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SUMMARY Classical beliefs about the functions of the dorsal columns of the spinal cord have been attacked following recent evidence that position and vibration sensations may be carried in the dorsal spinocerebellar tracts. There is evidence that the one specific function of the dorsal columns is for the transmission of information concerning the direction of tactile cutaneous movement. Thirty normal controls, 43 patients with spinal cord disorders and 10 patients with functional disorders were examined prospectively using an easily administered "direction of scratch" protocol. Interpretation of the direction of a 2 cm vertical tactile cutaneous movement over the lower limbs was found to be accurate in normal controls and grossly inaccurate in patients with functional disorders, exceeding the error rate of guessing. Detection of direction of 2 cm scratch was moderately impaired in 11 of 13 patients with spastic paraparesis and preserved sensation to all other modalities and 23 of 24 patients with spastic paraparesis and impaired proprioception and/or vibration sensations. Direction of 2 cm scratch, proprioception and vibration sensations were preserved in the three cases with anterior spinal cord syndromes. It is proposed that tactile perception of direction of 2 cm scratch over the lower limbs is a sensitive sign of posterior column function which can be usefully incorporated into the clinical sensory examination in the evaluation of spinal cord disorders.

The classical dictum that position and vibration sensations are functions of the spinal cord dorsal columns (posterior funiculi) has been undermined by clinical observations in humans[1–3] and neurobehavioural studies in animals.[4–7] In 1979, Ross *et al* presented clinical evidence which established that position and vibration sensations may be carried in the dorsal spinocerebellar tracts.[8] However, it seems from animal studies[9,10] and a few well documented human spinal cord injury cases[3] that a specific sensory function of the dorsal columns exists; this is the transmission of information concerning the direction of a moving cutaneous stimulus. Despite these findings the potential application of assessing the ability to detect the direction of a standardised tactile cutaneous movement as a routine clinical sign does not seem to have been explored.

We have examined both normal controls and patients with various spinal cord disorders using an easily administered "direction of scratch" protocol. The utility of this clinical sign as a test of cutaneous sensation and posterior column integrity was compared with the results of the more conventional bedside clinical tests of light touch, pain, temperature, vibration and joint position sense.

Materials and methods

The sharp end of a soft wooden tongue depressor, bisected in its long axis, was used to scratch the skin. Test sites included the anterior mid tibiae, halfway between the medial malleolus and tibial tuberosity; the mid thigh, halfway between the tibial tuberosity and the anterior superior iliac spine; the

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abdomen, 8 cm lateral to the umbilicus (unless a sensory level in the lower thoracic region was present, when each abdominal quadrant was tested); the chest, 4 cm above the nipple bilaterally; the upper limbs, halfway between the ulnar styloid and medial epicondyle, bilaterally.

A uniform random binary number sequence of 10 vertical scratches was performed over each anatomical segment. The subject was instructed as to the designated areas to be scratched, the number of scratches and the nature of the response required. Attention to the task was maintained by the examiner cueing the subject into each scratch, by saying "now". The subject was asked to state whether the direction of scratch was "up or down". An error was recorded if the subject either nominated the opposite direction of scratch, that the scratch was transverse or was uncertain of the direction of scratch. Initially, 10 scratches were performed using constant mild pressure. The length of the scratch was arbitrarily chosen to be 2 cm which was measured and marked on the skin. Each scratch was repeated every 2–3 seconds. The number of errors of interpretation of the direction of scratch out of 10 were recorded. If only one or two errors were made the examination was repeated to determine whether the errors were consistent or whether they were a result of a lack of attention to the tests. If consistent errors occurred, the examiner proceeded to perform 10 scratches over a measured 5 cm length and if further errors were noted the test was repeated over a measured 10 cm length. Most patients made less errors of interpretation of the direction of longer scratches, thus permitting the degree of error to be further quantified.

Vibration sensation was tested using a 128 Hz tuning fork. Assessment commenced at the distal interphalangeal joints of the upper and lower limbs and ascended to each more proximal joint if any impairment was detected. Proprioception was also examined at the distal interphalangeal joints with 5 mm joint displacement. If errors were present, the amplitude of joint movement was increased to 1 cm and subsequently 2 cm displacement. If further errors occurred then more proximal joints were assessed.

The patients included in this study had presented to a neurologist (RHE) and were examined prospectively. Normal controls consisted of healthy volunteers who were either staff or medical students of Royal Perth Hospital.

Results

Eighty-three subjects were assessed and allocated to one of three subgroups. Group A consisted of 30 normal control subjects. Group B comprised 43 patients with spinal cord disorders. Group C consisted of 10 patients with neurological symptoms in whom a functional disorder was diagnosed.

Group A

Of the 30 normal control subjects, 15 were male and 15 female. The average age was 34 years (range 21–54). Errors of interpretation of the direction of 2 cm scratch over the shins were made by only three normal controls, who each made just one error. Responses were normal at other test sites in all normal controls.

Group B (see table)

Of the 43 patients with spinal cord disorders, 31 were male and 12 female. The average age was 48 years (range 14–83).

(a) Spastic paraparesis with normal lower limb sensation (light touch, pain, temperature, vibration, joint position sense) but impaired detection of direction of cutaneous scratch was present in 11 patients. Cervicothoracic myelopathy due to intervertebral disc extrusion was the provisional diagnosis in four of these cases, spinocerebellar degeneration in four cases and spinal cord demyelination in three cases. A mean of three out of 10 errors of interpretation of direction of 2 cm scratch over the tibiae was made overall (range 0–6). The number of errors was equal in both lower limbs in all but three patients (demyelination 2, cervical myelopathy 1), in whom no errors were made in one leg and a mean of three errors (range 2–5) were made in the other leg. Direction of 5 cm scratch over the shins was misinterpreted a mean of 1·5 times out of 10 overall (range 0–3). Four patients made no errors bilaterally with 5 cm scratch.

Table *Results of interpretation of direction of scratch on the lower limbs of patients with spinal cord dysfunction (group B)*

Clinical syndrome	*Number of patients*	*Direction of scratch—Errors out of 10 (mean)*			
		2 cm (shins)	*5 cm (shins)*	*2 cm (thigh)*	*5 cm (thigh)*
(a) Spastic paraparesis & (N) sensation	11	3	1·5	2	0·5
	2	0	0	0	0
(b) Spastic paraparesis & bilaterally impaired vibration	4	5·5	1·5	4	1
(c) Spastic paraparesis & bilaterally impaired vibration & JPS	4	5	2	2	1
	1	0	0	0	0
(d) Spastic paraparesis & bilaterally impaired PP, Temp, LT	3	0	0	0	0
(e) Spastic paraparesis & bilaterally impaired LT, PP, JPS, Vib, Temp	8	5	2	4	1
	4				
(f) Spastic paraparesis & unilaterally impaired JPS, vibration	4	Ipsilat 5	3	2	1
		Contralat 3	1	1	0

JPS = joint position sense. Temp = temperature sensations. PP = sensations to pin prick. LT = light touch. N = normal.

Spastic paraparesis with preservation of all modalities of sensation, including direction of 2 cm scratch, was present in two cases of sporadic, adult-onset slowly progressive spastic paraparesis of uncertain aetiology.

(b) Spastic paraparesis with impaired vibration sensation and direction of 2 cm scratch in the lower limbs was present in four patients, of whom two had cervical myelopathy due to cervical spondylosis and two had thoracic spinal cord demyelination.

(c) Spastic paraparesis with impaired lower limb vibration, proprioception and detection of direction of 2 cm scratch but preserved spinothalamic sensation was present in four cases. Cervicodorsal demyelination was diagnosed in two cases and cervical myelopathy due to cervical spondylosis in the other two cases.

Spastic paraparesis with impaired vibration sensation at both ankles and proprioception at the right toes, but preserved detection of direction of 2 cm scratch, was present in one patient with multiple sclerosis who had a cervical plaque resulting in Lhermitte's phenomenon and mild spasticity, weakness and intermittent paraesthesis in the legs.

(d) Spastic paraparesis with abnormal spinothalmic but normal proprioception and vibration sensation was present in three patients, each with anterior spinal artery occlusion syndromes. Direction of 2 cm scratch was accurately determined by each case in all sites tested.

(e) Spastic paraparesis with impaired sensation to all modalities of sensation (light touch, pain, temperature, vibration sensation, joint position sense and direction of 2 cm scratch) was present in 12 cases. The provisional diagnosis was transverse myelitis (4 cases), cervico-dorsal demyelination (4 cases), spinal cord tumour (2 cases), syringomyelia (1 case) and cervical myelopathy secondary to cervical spondylosis (1 case). The four patients with transverse myelitis all had no idea of the direction of 2 cm, 5 cm or 10 cm scratch below the level of the spinal cord lesion. Excluding the four cases with transverse myelitis, the direction of 2 cm scratch over the shins in the remaining eight cases was misinterpreted a mean of five out of 10 times (range 3–10) and over the thigh a mean of four out of 10 times (range 2–8).

(f) Spastic paraparesis with unilateral impairment of proprioception and vibration sensation was present in four cases. Cervicodorsal demyelination was diagnosed in three patients and spinal cord compression by calcified ligamentum flavum at T11/T12 in one patient. Direction of 2 cm scratch over the tibia ipsilateral to the lesion was misinterpreted a mean of five out of 10 times (range 4–8) and a mean of three out of 10 times (range 0–4) over the tibia contralateral to the lesion.

One patient with neurosyphilis had lower limb areflexia and impaired vibration and proprioception at the ankles. Direction of 2 cm scratch was misinterpreted six out of 10 times bilaterally over the shins but accurately detected over the thighs.

One patient with vitamin B12 deficiency characterised by spastic paraparesis, impaired proprioception and vibration sensation to the ankles and lower limb areflexia made five out of 10 errors of interpretation of 2 cm direction of scratch bilaterally over the shins but accurate responses to scratch over the thighs.

Group C

Ten patients who presented with neurological symptoms were considered to have a functional disorder on the basis of their clinical history, "give-way" weakness, non-anatomical sensory deficits and lack of objective neurological signs. Errors of determining the direction of 2 cm scratch over the tibiae were made a mean of eight out of 10 times bilaterally (range 5–10). Direction of 5 cm and also 10 cm direction of scratch were also misinterpreted a mean of eight out of 10 times. Error rate was consistent throughout the lower limbs, trunk and upper limbs in most (70%) cases.

Discussion

The role of the posterior columns of the spinal cord in transmitting information concerning the direction of tactile cutaneous movement has been established from clinical and experimental animal studies. Wall and Noordenbos (1977) carefully examined three patients with defined lesions of the thoracolumbar spinal cord, including the dorsal columns, and concluded that patients with dorsal column lesions do not lose one or more of the classic primary modalities of sensation but lose an ability to carry out tasks where they must simultaneously analyse spatial and temporal characteristics of the stimulus.[3]

Vierck (1974) showed that monkeys with cut dorsal columns could differentiate between stationary and moving stimuli but were severely impaired in their ability to detect direction of movement.[9]

In view of the ongoing reappraisal of dorsal column function[11] it was our interest to assess the utility of interpretation of direction of cutaneous scratch as a clinical sign of posterior column function, particularly in patients with spinal cord syndromes, and to compare it with tests of vibration and position sense.

Interpretation of direction of a 2 cm vertical tactile cutaneous movement on the lower limbs was found to be accurate in normal controls (group A) with no more than one error out of 10. On the contrary, patients with functional disorders (group C) made consistent errors considerably exceeding the error rate of guessing. The majority of patients in this survey, however,

had various spinal cord disorders (group B). Interpretation of direction of 2 cm scratch was mildly to moderately impaired in nearly all patients in this group.

The consistent impairment of interpretation of direction of 2 cm scratch over the shins a mean of three in 11 of the 13 patients with spastic paraparesis and normal appreciation of all other modalities of sensation suggests subtle posterior column sensory impairment in those patients. The higher error rate (mean 5·5 out of 10) in patients with spastic paraparesis and impairment of lower limb vibration sensation only and (mean five out of 10 errors) in patients with spastic paraparesis and impairment of lower limb joint position sense and vibration sensation, further supports the sensitivity of this modality of sensation in detecting posterior spinal cord dysfunction. The localisation of these sensory functions to the posterior spinal cord is further enhanced by the preservation of proprioception, vibration sensation and direction of 2 cm scratch in the three patients with anterior spinal syndromes causing spastic paraparesis and spinothalmic sensory dysfunction only. These findings are consistent with clinical and experimental evidence that the preserved modalities of sensation (joint position sense, vibration sense and interpretation of direction of 2 cm scratch) ascend in the posterior part of the spinal cord, supplied by the posterior spinal artery.[3,8,9]

Although direction of scratch reliably conformed with other sensory and motor deficits to accurately determine the level of the lesion in our patients with transverse myelitis, it was not our experience that the direction of cutaneous sensation was as reliable in detecting a spinal cord sensory level in patients with more subtle causes of myelopathy.

The results of this study indicate that errors in the detection of direction of scratch on the skin in spinal cord disorders usually correlates with position and/or vibration sense impairment in the legs. However, the test protocol, which is easy to quantify, has utility in confirming or denying a sensory abnormality in the legs when position or vibration sense test results are equivocal. Furthermore, errors of interpretation of direction of scratch may occur as an isolated sensory abnormality. In our view, a detection of direction of 2 cm scratch protocol can be usefully incorporated into the clinical sensory examination, especially for the evaluation of spinal cord disorders.

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