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Original Article

Usefulness of Manual Muscle Testing of Pronator Teres and Supinator Muscles in Assessing Cervical Radiculopathy

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Abstract Laterality of muscle weakness between the pronator teres and supinator muscles (LPS) and MR images of the cervical spinal cord were examined in patients with cervical radiculopathy (CR) and age-matched controls. The LPS diagnostic sensitivity (95 of 115 patients, 82.6%) and specificity (77 of 102 patients, 75.5%) in CR are significant. Eighteen patients who showed no amelioration of LPS within 2 to 4 weeks had high probability of moderate to severe cervical disc protrusion. LPS is a simple but useful test for the detection of cervical lesion and prediction of its prognosis.

Key words: manual muscle testing; pronator teres muscle; supinator muscle; MRI; cervical disc herniation; cervical lesion

1. INTRODUCTION

Manual muscle testing (MMT) of the biceps, brachioradialis and triceps is commonly used to check the C-5, C-6 and C-7 cervical roots in evaluations of cervical lesions. The sensitivity of these muscles for the detection of minor cervical lesions is, however, low because their strength is too great to detect fine muscle weakness. Further, the clinical symptoms of cervical lesion do not always correlate with the severity of the neuroimaging diagnosis because MRI is too sensitive to rule out a silent cervical lesion, especially in aged persons. For example, MRI findings showed that 36% of asymptomatic subjects aged 60 or older had a herniated nucleus pulposus and 21% had spinal stenosis in the lumbar or cervical spine[1)].

We evaluated the validity of clinical MMT in detecting laterality of strength in the pronator teres muscle, the muscle innervated by the C-6 and C-7 nerve roots, and the supinator muscle strength, which is innervated by the C-5 and C-6 nerve roots, in patients with uspected cervical radiculopathy (CR). Findings were compared with those of diagnostic imaging in terms of clinical prognosis. MMT of the pronator teres and supinator muscle is useful for detecting morbid but fine cervical

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lesions in the C-5, C-6 and C-7 nerve roots, common sites of such lesions, and its prognosis.

2. Materials and Methods

Clinical examination

We selected a group of 115 Japanese patients with newly diagnosed clinical CR and 102 age-matched controls (normal volunteers who visited the National Omuta Hospital and Omuta Rosai Hospital Brain Dock Section). The patients with CR had visited our hospital within the first to the seventh day after the onset of symptoms (mean 2-3 days).

The clinical criteria for CR were (1) a history indicative of CR (neck pain, arm pain, pain and/or numbness in an upper limb) and exacerbation of symptoms by the Spurling maneuver and/or a change in neck position, (2) an abnormal motor examination for myotomal distribution, except the pronator teres and supinator muscle, when the range of motion of the upper extremities was evaluated by the usual MMT, (3) abnormality in the sensory examination showing a dermatomal pattern and (4) a positive electrophysiological examination (especially F-wave conduction velocity, decreased F wave number or needle EMG). Subjects meeting two or more of these criteria were classified as having CR[2]. Patients with clinically and neurophysiologically diagnosed mononeuritis, mononeuritis multiplex, polyneuropathy, brachial plexopathy, metastatic tumors, cerebrovascular diseases, myelopathy or motor neuron diseases were excluded.

We detected the focal (one side or the other) difference in the strength of the pair of muscles by MMT[3]. Laterality between the pronator teres was examined first and supinator muscle power next (Fig. 1a, b). If the examiner detects weakness of muscle in one of those four muscles, we classified it as positive laterality of pronator teres and supinator muscle power (LPS). We also examine laterality of biceps and then triceps muscle power (LBT). If the examiner detects weakness of muscle in one of those four muscles, we classified it as positive LBT. LPS was checked with the patient in the sitting position, the forearm in a neutral position (Fig. 1a) or in the forearm-

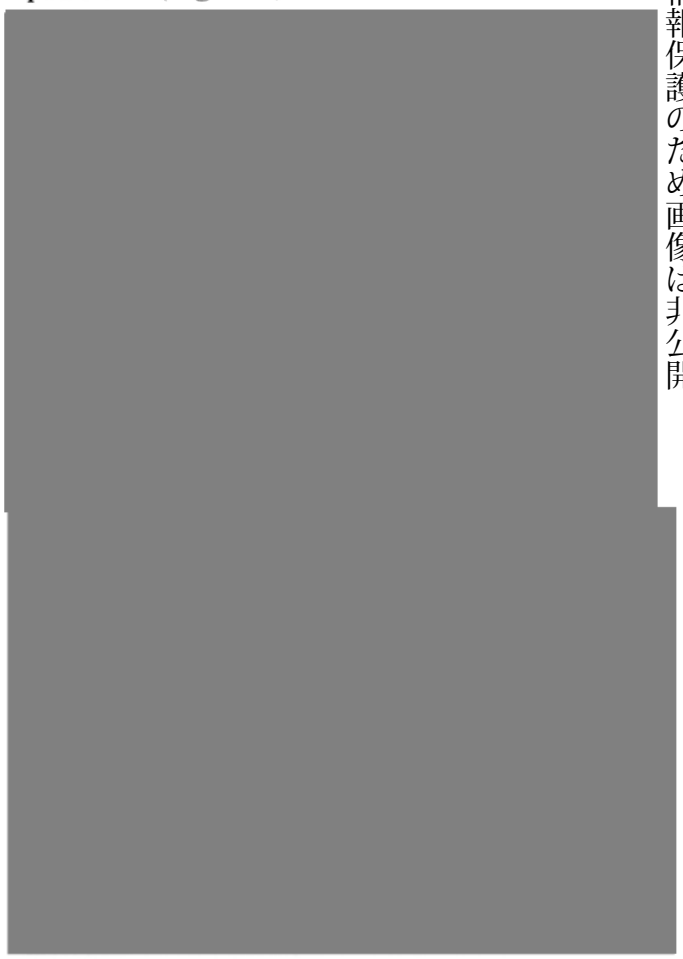

Fig. 1 Evaluation of LPS by manual muscle testing (MMT). Original method of MMT for pronator teres and supinator muscles in a sitting position (a) and in a supine position (b). The subject adducts her forearm while the examiner checks the pronator teres muscles (shaded arrows) and abducts them while he checks the supinator muscles (white arrows). Examiners are able to evaluate the muscle power of both sides of pronator teres or supinator simultaneously.

extended position if the patient was supine (Fig. 1b). Severity of LPS was also evaluated by MMT grading.

These clinical evaluations were redone by neurologist two or four weeks after the first examination and only the use of conservative treatment (physiotherapy and/or non-steroidal anti-inflammatory drugs therapy). Patients with both pronator teres and supinator muscle weakness and/or weakness in both hands were also excluded. We also evaluated the correlation between hand dominance and LPS by independent examinations of another 67 normal control subjects.

Neuroimaging

The routine cervical MRI (1.0T, Gyroscan T10-NT ; Philips Co.) protocol consisted of T1-and T2-weighted sagittal and axial images. In neuroimaging diagnosis, we focused on the existence of myelopathy rather than radiculopathy for two reasons. First, the most important objective in bedside neurological diagnosis of a cervical lesion is to determine whether a patient needs further intensive evaluation for surgical treatment or not. Recent clinical opinion deems surgical treatment appropriate for only severe radiculomyelopathy or myelopathy, with most radiculopathy cases treated conservatively at first[4]. Second, grading cervical radiculopathy by neuroimaging in the axial view of MRI is rather difficult, especially in elderly people, most of whom have deformity of the cervical vertebrae[5].

To avoid differences in neuroimaging diagnoses in each case, we adopted simplified diagnostic criteria. Criteria for severe to mild cervical lesions were (1) marked deformity of the spinal cord in axial images, sometimes accompanied by an increased T2 signal from the middle of the cord in sagittal or axial image, (2) mild to moderate compression of the spinal cord without severe deformity in axial image, or (3) absence of deformity of the spinal cord or presence of disc herniation that merely abutted neural structures[1)6)].

Neuroimages (cervical MRI) were analyzed independently ; i.e., the clinical examiner was blinded until the second clinical examination was finished. Information concerning subjective clinical symptoms, objective neurological findings, and neuroimaging reports on the patients was stored in a FileMaker Pro 6.0 database (File-Maker, Pro. Inc.). The χ^2 test was used for the statistical analysis, except for the analysis of correlation between the severity of LPS and MRI imaging, which was analyzed with Sperman rank correlation test (Table 4).

3. Results

We first evaluated the correlation between hand dominance and LPS in 67 normal volunteers (60 dextral, 7 sinistral, mean 57.0 years old). Eleven showed mild LPS (9 dextral, 2 sinistral). Of the 9 with dextral LPS, five had LPS in the right hand and four in left. The two sinistrals had LPS in the right hand. Statistically, our maneuver to detect LPS was not affected by hand dominance ($p=0.272$).

Next, the 217 subjects were divided into 2 groups based on neurological analyses : 115 patients with clinically diagnosed CR and 102 age-matched controls. Ages ranged from 20 to 89, with a mean of 62.3 years in the CR group and 62.5 years in the control group.

The correlation between laterality of muscle weakness and the clinical diagnosis is presented in Table 1. The diagnostic sensitivity of MMT for a fine cervical lesion

when LPS was used is high (95 of 115 patients, 82.6%) as compared with LBT (21 of 115 patients, 18.3%). In contrast, the specificity of LPS (77 of 102 patients, 75.5%) was about the same as that of LBT (91 of 102 patients, 89.2%).

We next analyzed the correlation between the LPS prognosis and MRI findings. Of the 115 patients with CR, 40 underwent a cervical neuroimaging examination and a second complete neurological examination. The 40 patients were divided into two groups according to their LPS prognosis. Group 1 consisted of 20 patients who showed no LPS improvement over 2 to 4 weeks, and were classified as within normal limit (1 patient, 5%), mild (5 patients, 25%), moderate (12 patients, 60%) or severe (2 patients, 10%) on the basis of MRI findings. Group 2 consisted of 20 patients who showed amelioration of LPS within 2 to 4 weeks, and were classified as within normal limit (2 patients, 10%), mild (15 patients, 75%), moderate (2 patients, 10%) or severe (1 patient, 5%) on the basis of neuroimaging findings.

A statistical significance was found between groups 1 and 2 for mildly and moderately affected findings (Table 2). Patients in group 1 (66.6%) had statistically high probability of moderate to severe cervical MRI findings whereas those in group 2 had high probability of normal to mildly abnormal MRI findings ($p<0.001$). No statistical significance was proved when groups were separated into normal and mildly or moderately and severely involved on the basis of MRI findings ($p=0.500$, $p=0.500$) (Table 2). The accuracy between MMT and MRI diagnosis was statistically evaluated and the significance of LPS, especially that of spinator muscle, was shown ($p=0.001$) (Table 3). The correlation between the severity of LPS and the MRI findings was also evaluated, but there was no statistical significance ($p=0.058$) (Table 4).

4. Discussion

MRI to detect cervical lesions is often too sensitive, especially in aged people, to detect the candidate lesion. On the other hand, a mild cervical lesion sometimes causes severe clinical symptoms that are not necessarily detectable in an MRI examination. Our study shows that MMT of the pronator teres and supinator muscle can detect fine cervical lesions in the upper limbs. The MMT of these muscles is correlated with the diagnosis of CR, MR images of cervical lesions and the patient's prognosis.

The importance of a neurophysiological examination, especially EMG, for the diagnosis of CR has been reported[7]. The importance of pronator reflex or H-reflex studies in appropriate muscles also has been emphasized for evaluating C-6 and C-7 root lesions[2)8)9)], but these reports were based on neurophysiological examinations. The LSP maneuver is a simple and easy-to-perform clinical examination that can be done repeatedly.

The fact that 25 of the 102 normal controls (24.5%) were LPS positive may raise the question of over-diagnosis (Table 1). The mean age of the population in our study however was much higher than of populations in previous reports, and a difference in the prevalence of spondylosis has been suggested between aged Asians and Caucasians[10)11)]. It was also reported that Japanese patients with cervical spondylotic amyotrophy showed C4/5, 5/6, 6/7 lesions commonly[12)], and our data showed similar result (Table 3). The high incidence of LPS in our data (Table 1) may reflect that (1) the increased tendency toward spinal stenosis in

Table 1 Laterality of pronator teres and supinator muscle weakness (LPS) or of biceps and triceps muscle weakness (LBT)

	LBT (+)	LBT (-)	$p=$	LPS (+)	LPS (-)	$p=$ (†<0.05)	total
cervical radiculopathy	21	94	0.086	95	20	<0.001 †	115
age-matched control	11	91	-	25	77	-	102
total	32	185	-	120	97	-	217

Table 2 Improvement of LPS and neuroimaging evaluation of cervical radiculopathy

improvement of LPS within 2-4 weeks of onset of cervical radiculopathy	(Group 1) negative	(Group 2) positive	total	$p=$ (†<0.05)
MR imaging				
within normal limit	1	2	3	
mild	5	15	20	0.500
moderate	12	2	14	<0.001 †
severe	2	1	3	0.500
	20	20	40	

Of 115 patients with cervical radiculopathy, 40 underwent both MRI and repeated neurological examinations.

Table 3 Site of lesion diagnosed with MRI and LPS at first neurological examination

MRI imaging	Laterality of	pronator teres (C6, C7)	supinator (C5, C6)	case*
site of lesion of disc protrusion	compression level			
C4/C5	C5	1	10	11
C5/C6	C6	5 $p=0.031$ ¶	15 $p=0.001$ †	20
C6/C7	C7	9	3	12
C 7/Th 1	C8	5	3	8
total		20	31	51

(*) Some of the patients have double lesions in MRI diagnosis. So, we excluded such cases. ¶: $p<0.05$, †: $p<0.01$

Table 4 Correlation between the severity of LPS and MRI imaging diagnosed as cervical radiculopathy

LPS	(-)	(+)			
MRI imaging		mild	moderate	severe	total
protrusion of disc					
within normal limit	1	13	26	5	45
mild	5	8	8	1	22
moderate	12	11	9	1	33
severe	2	6	6	1	15
total	20	38	49	8	115

$p=0.058$ (Spearman rank correlation test)

Japanese 60 years or older, who are asymptomatic now, but have a risk of CR at any time, or (2) the simple technical problem in MMT. Further investigation including the research study for LPS pseudo-positive frequency in large age matched control or the large number study of LPS in CR will be needed.

Moreover, we suggest there is a correlation between the prognosis of LPS and the diagnosis of MRI (Table 2). According to our findings, patients assessed by MRI as having moderate to severe compression of the cervical spinal cord showed poor recovery from LPS within 2 to 4 weeks of the onset of symptoms. In contrast, MR images of those diagnosed with normal to mild cervical lesions showed good LPS recovery within that period. Accordingly, following the status of LPS is very important in predicting the prognosis for moderate to severe cervical lesions. Our preliminary findings also show a statistically significant correlation between tension headache and LPS (data not shown). This confirms previous findings as well as the usefulness of LPS for evaluating other clinical symptoms[13)14)].

In conclusion, detection of LPS is a simple maneuver that can be used to find a fine cervical lesion and to predict its prognosis. Repeated MMTs of the pronator teres and supinator muscle should be used more extensively in bedside neurological examinations.

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(和文抄録)

頸椎根病変の評価に対する，円回内筋，回外筋徒手筋力検査の有用性についての検討

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頸椎神経根症(CR)の患者さんと年齢補正した正常者群との間で，円回内筋と回外筋の筋力の左右差を徒手筋力検査で検出し(LPS)，それと頸部MRI画像に認められる脊髄病変の程度について検討した．CR患者群において，LPSを診断法として用いた感度（115名中95名で，82.6%）と，特異性（102名中77名で，75.5%）は有意に高かった．また，2～4週間の間にLPSの改善を認めなかった18名のCR患者では，画像上中程度から高度の頸椎椎間板の突出が認められた．このことから，LPSは頸椎病変の検出と，その予後を予測するために有用な，臨床で簡単に行える手技と考えられた．