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Relationship between Electromyography and Computed Tomography in the Evaluation of Low Back Pain

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In a group of 109 patients with low back pain, the electromyographic(EMG) findings were compared with computed tomographic (CT) findings. There were 64 (58.7%) patients who had abnormal EMG results combined with abnormal CT findings. 11 (10.1%) cases had abnormal EMG and normal CT findings, another 11 (10.1%) patients had abnormal CT and normal EMG findings. 33 patients underwent operation; nerve root compressions were confirmed in all those with abnormal EMG findings, and 32 of those with abnormal CT findings. Among 33 surgical cases, 24 (72.7%) patients had abnormal EMG findings in both paralumbar and lower extremity muscles. In 9 (27.3%) patients there was evidence of abnormal EMG findings in the paralumbar muscles only. Among 46 who had abnormal EMG findings in paralumbar and lower limb muscles, 44 (95.6%) patients had combined CT abnormalities, and in the remaining 2 patients, nerve root 'compression was confirmed by surgery in 1 case and by myelogram in the other. In 29 cases with abnormal EMG findings in the paralumbar muscles only, 20 (69.0%) patients had combined CT abnormalities. In comparing normal versus abnormal EMG findings of the paralumbar muscles only, a significantly higher percentage of abnormal CT results were found among the abnormal EMG findings. These results indicate that abnormal EMG findings in both the paralumbar and lower limb muscles, strongly suggests the presence of nerve root compression. In cases where there are abnormal EMG findings in the paralumbar muscles only, it is recommended that CT scan must be done for the correct diagnosis of low back pain.

Key Words: Low back pain, EMG, CT

Low back pain with radiation to one or both lower extremities is the most common disabling musculoskeletal symptom and the most frequent cause of limitation of activities. There is a wide range of different etiologies and various modalities of treatment for low back pain. For adequate treatment, the clinician should determine if the symptom is the result of a neurological compromise due to pathological changes in the spinal anatomy. This can be accomplished by EMG, myelographic and CT studies.

Myelography is a diagnostic tool to evaluate structural abnormalities. However it has side effects, such as severe headaches, arachnoiditis, allergic reaction, infection and seizures (Khatri *et al.* 1984).

Most recently CT has been used to delineate osseous structures and to discriminate the soft tissues within the spinal canal with great clarity. The accuracy of results of CT in low back pain patients is variable among investigators(Williams *et al.* 1980; Wiesel *et al.*; 1984). However, CT has the advantages of being noninvasive and having no side effects as in myelography. As a result, CT has be-

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come the most popular diagnostic tool for the evaluation of low back pain.

Electromyography is an important diagnostic method with a high degree of accuracy and with widespread clinical application. It is a method to detect neurophysiologic changes of specific spinal nerve roots and is technically simpler than myelography as a preliminary screening test (Crue *et al.* 1957). In our clinical experience, abnormal EMG findings were seen only in paralumbar muscles in many patients with low back pain. In these cases we had some trouble distinguishing with certainty whether these findings were due to true raduiculopathy or merely to paralumbar muscles spasm without spinal nerve root compromise. The purpose of this study is : (1) to compare the findings of EMG and CT in low back pain patients, in order to find out the correlation of EMG to CT so that some reliable guideline can be obtained in the evaluation of these patients. (2) to find out the significance of abnormal EMG findings when appearing only in the paralumbar muscles.

MATERIALS AND METHODS

There were 109 subjects with low back pain who underwent CT and EMG between Jan. 1986 and Dec. 1989. Of the 109 patients ranging in age from 12 to 78 years, 68 were men and 41 were women. Among them, 33 patients underwent spinal surgery and 76 patients received conservative treatments.

In all cases, EMG studies were done three more weeks after the onset of low back pain. Their peripheral nerve conduction studies showed normal range for both motor and sensory fibers. Electromyographic studies were carried out in the lower extremity and paralumbar muscles. Fibrillation and positive sharp wave potentials detected by needle examination in at least two separate areas of a specific muscle were read as abnormal.

The CT scans were considered to be pathologic if any of the following were noted: displacement of epidural fat by posterior disk margin, indentation of dural sac, disk protrusion and herniation, calcification within disk protrusion, soft tissue mass in epidural fat, displacement of dural sac, compression and displacement of nerve root sheaths.

RESULTS

EMG findings were abnormal in 75 patients and normal in 34 patients among the 109 study subjects. 64 (85.3%) out of the 75 cases with abnormal EMG findings had abnormal findings on their CT's. Whereas, 11 (32.4%) of the 23 patients with normal EMG findings had abnormal findings on their CT's. There is a strong relationship between EMG and CT findings ($p<0.01$)(Table 1).

Among 75 patients with abnormal EMG findings, 46 cases revealed abnormalities in both paralumbar and lower limb muscles. The remaining 29 patients had EMG abnormalities only in the paralumbar muscles. 33 patients had undergone surgical procedures at which time nerve root compressions were identified in 100% of the cases. Among these 33, 24 patients had abnormal EMG findings in both paralumbar and lower limb muscles, and 9 patients in the paralumbar muscles only.

When the 76 cases with conservative treatments were examined, only 42 patients had EMG abnormalities. 22 of these 42 patients had EMG abnormalities in both paralumbar and lower limb muscles, while 20 patients had them in the paralumbar muscles only. There was no any significant relationship between location of abnormal EMG findings and method of treatment($p>0.01$). These observation indicate that in cases where there are abnormal EMG findings in paralumbar

Table 1. Comparison between EMG findings and CT findings of low back pain

	No. of cases(%)		Total
	Abnormal EMG	Normal EMG	
Abnormal CT	64 (85.3)	11 (32.4)	75
Normal CT	11 (14.7)	23 (67.6)	34
Total	75 (100.0)	34 (100.0)	109

$\chi^2=30.59(p<0.01)$

Table 2. Location of abnormal EMG findings

	No. of cases with abnormal EMG (%)		Total
	Paraspinal & lower limb muscles	Paraspinal muscles only	
Surgical management	24 (52.2)	9 (31.0)	33
Conservative management	22 (47.8)	20 (69.0)	42
Total	46 (100.0)	29(100.0)	75

$\chi^2=3.22$ ($0.05<p<0.1$)

Table 3. Comparison between EMG findings & CT findings

	No. of cases(%)		Total
	Abnormal EMG findings only in paralumbar muscles	Normal EMG findings	
Abnormal CT	20(69.0)	11(32.4)	31
Normal CT	9(31.0)	23(67.6)	32
Total	29(100.0)	34(100.0)	63

$\chi^2=8.39$ ($p<0.01$)

Table 4. Comparison between location of EMG abnormalities & CT findings

	No. of cases with abnormal EMG(%)		Total
	Lower limb & paralumbar muscles	Paralumbar muscles only	
Abnormal CT	44 (95.6)	20 (69.0)	64
Normal CT	2 (4.4)	9 (31.0)	11
Total	29 (100.0)	46 (100.0)	75

$\chi^2=10.12$ ($p<0.01$)

muscles, surgical treatment as well as conservative treatment should be considered as the treatment method of low back pain (Table 2).

Among 29 patients with abnormal spontaneous activities detected only in the paralumbar muscles, 20 (69.0%) patients had abnormal CT findings. Among 34 patients with normal EMG findings, 11 patients had abnormal CT findings. The relationship between abnormal EMG findings in the paralumbar muscles only and abnormal CT findings were statistically significant($p<0.01$) (Table 3).

In the 46 patients showing abnormal EMG findings in both paralumbar and lower limb muscles, 44 (95.6%) patients were found to have abnormal CT findings. In the remaining 2 patients, the presence of nerve root compromise was confirmed by surgery or by myelogram. Consequently, all the patients who showed abnormal spontaneous activities in both paralumbar and lower limb muscles, proved to have spinal nerve root compression. And among the 29 patients in whom abnormal EMG findings were detected only in

Table 5. CT and EMG findings in surgical treatment group

	No. of cases (%)	
	Abnormal CT	Normal CT
Abnormal EMG		
Paraspinal & lower limb	23 (69.7)	1 (3.0)
Paraspinal muscle only	9 (27.3)	0 (0.0)
Normal EMG	0 (0.0)	0 (0.0)
Total	32 (96.0)	1 (3.0)

the paralumbar muscles, 20 (69%) patients showed abnormal findings in CT. In the abnormal CT findings, there was a stronger association with the abnormal EMG findings in both paralumbar and lower limb muscles than with abnormal EMG findings in the paralumbar muscles only ($p<0.01$) (Table 4).

In all of the 33 surgical patients, spinal root compression was confirmed during the operation. The EMG findings were abnormal in all the patients while the CT findings were abnormal in 32 patients, and normal in 1 patient. And 24 of the surgical patients had abnormal EMG findings in both the paralumbar and the lower limb muscles. Among them, 1 patient had a normal CT finding. 9 patients showed abnormal EMG findings in the paralumbar muscles only, and all the patients showed abnormal CT findings (Table 5). Therefore, this observation clearly indicates that an EMG study is a very sensitive method for detecting spinal nerve root compromise.

DISCUSSION

There are various methods of diagnosing low back pain. The correct diagnosis is essential for the proper management of it. Many causes of sciatica have been enumerated by Macnab (1977).

With the advancement of CT technology, it is now possible to get excellent anatomic information of the spinal canal (Jacobson *et al.* 1975; Hammerschlag *et al.* 1976; Sheldon *et al.* 1977; Lee *et al.* 1978; Haughton *et al.* 1980). High resolutional CT has been the biggest milestone in the diagnosis and management of low back pain. CT has contributed to reducing the morbidity, while simultaneously increasing diagnostic accuracy.This is shown by a 98% diagnostic accuracy of lumbar CT of patients with low back pain (Lee *et al.* 1986). In a report by Williams *et al.* (1980), the correlation of CT evidence of herniated discs with the findings of surgery was very striking in all of 16 patients who underwent surgical exploration. However, there is one drawback in that the cost of CT examination is very high. Electromyography, devoid of morbidity and significant side effects, has gained ever increasing clinical importance in the diagnosis of lumbar root compression syndrome. Needle electromyography is the most useful electrophysiologic test for evaluating radiculopathies. The value of EMG in evaluating low back pain is well recognized (Knutsson. 1961; Flax *et al.* 1964; Gough and Koepke. 1966; Johnson and Melvin. 1969, 1971; Seppalainen *et al.* 1981). Shea, Woods and Werden showed in 1950 that in 60 operated lumbar disc herniations, electromyography proved the diagnosis in 90 per cent of the cases. Knutsson in 1959 reported that EMG was correct in 100% of 24 patients with lumbosacral disc herniation. Lajoie (1972) reported that the accuracy of EMG was 87%, while the accuracy of the myelogram was 100%. Chung *et al* (1980) observed that the accuracy of electromyography was 73.4% and that of myelogram was 79.7% in 64 cases having disc herniation. Leyshon *et al* (1981) reported that the accuracy of electrical study in the diagnosis of compression of the lumbar root was 90%. As mentioned above, the accuracy of diagnosis for EMG has been variable among investigators. In this study electromyographic findings were compared with CT and surgical findings to discover the correlation between them. This study showed that in cases of surgical operation, the accuracy of EMG was 100%, but the accuracy of CT was 96.7%. Therefore EMG is considered to be a more sensitive diagnostic method in detecting root compression. The electrophysi-ologic evaluation of radiculopathies is therefore important and challenging. Therefore it is recommended that both a CT and an EMG study be done for a correct diagnosis of low back pain.

In 1971, Johnson and Melvin reported that

for almost one-third of the patients with surgically confirmed lumbar disc herniation, abnormal EMG findings were demonstrable only in the posterior primary ramus innervating paralumbar muscles. In 1972, LaJoie reported that abnormal EMG findings in both paralumbar and lower limb muscles were observed in 70% of his cases. This study shows that 75 (68.8%) of 109 patients had abnormal electromyographic findings. 29 (38.7%) of these 75 patients had abnormal EMG findings limited to the paraspinal muscles. Over two-thirds of them had abnormal CT findings. The patients with abnormal EMG findings in the paralumbar muscles only had a higher probability for abnormal CT findings than those with normal EMG findings. These observations indicate that in cases where there are abnormal EMG findings in paralumbar muscles only, there is a relatively high probability of radiculopathy. In these cases other radiological studies like CT scan, should be done for a correct diagnosis of low back pain. In 33 patients in whom nerve root compression was confirmed by surgery, all had abnormal EMG findings, but 9 patients among them had abnormal EMG findings in the paralumbar muscles only. 46 (61.3%) of 75 patients had abnormal EMG findings in both the paralumbar and the lower limb muscles. 44 (95.6%) cases had abnormal CT findings and 24 (52.1%) of 46 patients underwent surgery that confirmed spinal nerve root compression. This study demonstrated that if abnormal EMG findings are detected in both paralumbar and lower limb muscles, it can be stated that the spinal nerve root is definitely compressed.

CONCLUSION

In surgical cases with confirmed nerve root compression, almost one-third of the patients had abnormal EMG findings limited to the paralumbar muscles. And in almost two-thirds of the patients with abnormal EMG findings limited to the paralumbar muscles, abnormal CT findings were noted. This observation indicates that in cases with abnormal EMG findings noted only in paralumbar muscles, correlation with CT findings is very important for the detection of radiculopathy because the abnormal EMG finding in paralumbar muscles is an important clue pointing to radiculopathy. However, when abnormal EMG findings are noted in both paralumbar and lower limb muscles, it can be said that the nerve root is definitely compressed.

As stated above, EMG studies were shown to be a very sensitive diagnostic method and therefore, both CT and EMG evaluations are recommended for a correct diagnosis of low back pain.

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