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F-Wave Studies in L5 Radiculopathic Patients Receiving Automated Percutaneous Lumbar Disectomy

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Background and purpose: Herniated intervertebral disc with radiculopathy may prolong F-latency and reduce F-persistence. The aim of this study was to investigate changes of F-waves in patients with L5 radiculopathy before and after automated percutaneous lumbar disectomy (APLD).
Methods: Eight patients (aged 26 to 39 years) with L5 radiculopathy were recruited. The L5 radiculopathy was diagnosed by radicular pain and motor/sensory deficit and was confirmed by MRI. F-latency and persistence of the deep peroneal nerve were measured before and after APLD. To enhance the F-wave response, a stimulus duration of 0.3 ms was used, and patients were asked to contract the masseter muscles.
Results: The F-persistence showed a significant increase ($p < 0.05$) after APLD (42.5% ± 11.7% and 66.3 % ± 10.6% before and after APLD, respectively). The F-latencies of the deep peroneal nerve showed a decreasing trend after APLD (46.19 ± 3.58 ms and 44.76 ± 2.69 ms before and after APLD, respectively). The increase of F-persistence may be explained by increased nerve excitability after APLD. F-latency may lack the sensitivity to show the change after APLD because F-latency possibly reflects only a small portion of motor neuron fibers affected.
Conclusions: We conclude that F-persistence is more sensitive than F-latency in monitoring nerve root decompression after APLD. Understanding the role of F-persistence in evaluating the nerve root condition requires further study. (J Rehab Med Assoc ROC 2000; 28(4): 213 – 219)

Key words: F-persistence, F-latency, automated percutaneous lumbar disectomy

INTRODUCTION

Electrophysiological techniques provide useful information for both diagnosis and prognosis of lumbosacral radiculopathies. Examination of late potentials such as F-wave or H-reflex as well as needle electromyography (EMG) is helpful in evaluating lumbosacral radiculo- pathy[1-3].

Automated percutaneous lumbar disectomy (APLD) is selective removal of nucleus pulpous from a herniation site with various automated instruments under endoscopic control. The mechanism was thought to be indirect reduction of the disc hernia by an intranuclear vacuum

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phenomenon. Previous literature revealed that APLD appears to be effective in the amelioration of lumbosacral radiculopathy[4,5]. However, there are no reports on detecting changes of root compression after APLD using electrophysiological evaluations.

Although needle EMG is valuable for the diagnosis of lumbosacral radiculopathy, changes of EMG with lumbosacral radiculopathy after operation remain controversial. Johnson and Fletcher[6] , in a review of 100 cases of lumbosacral radiculopathy, found that EMG showed an increase in the recruitment pattern and reduction in the number of fibrillation potentials and positive sharp waves after recovery. In contrast, Negrin and coworkers[7] reported a high percentage of no change with needle EMG after conservative or surgical treatment. Furthermore, both radiculopathy and root trauma after surgery may show positive sharp wave and fibrillation potentials on EMG of paraspinal muscles. The use of needle EMG may not be sufficient to evaluate the recovery of root compression before and after surgery.

F-waves, late responses that can be recorded from a muscle following supramaximal stimulation of motor nerve fibers, are helpful in identifying the involved roots and in determining the level of single disc prolapse[8]. Compared with needle EMG, F-wave can detect abnormalities earlier. In addition, F-wave is capable of detecting mild root lesions which do not cause axonal degeneration[1,2].

F-latency and F-persistence are the most widely used parameters of F-waves in detecting both generalized and localized nerve disorders. Although these two parameters have been useful in evaluation of both upper and lower motor neuron diseases, their diagnostic value in detecting lumbosacral radiculopathies is not well determined. Furthermore, there are few reports of the use of F-wave in detecting changes in lumbosacral radiculopathy after surgical intervention.

Although F-waves have been commonly used to evaluate lumbosacral radiculopathy, their role in monitoring the severity of radiculopathy is not well established. The aim of this study was to investigate changes of F-waves in patients with L5 radiculopathy before and after APLD. Furthermore, the clinical usefulness of F-waves is discussed.

METHODS

Subjects

Eight patients (5 males and 3 females) with low back pain, aged 26 to 39 years (mean 31.8), were included in this study. Of the eight patients, 4 of them had radicular pain only, 2 had motor weakness and radicular pain, and 2 patients had both radicular pain and sensory abnormality. All of them had shown L4~5 herniated discs on MRI before operation. Root compression caused by L4~5 herniated disc were confirmed by MRI. Patients with upper motor neuron lesions, diabetes, renal failure, alcoholism, or a history of any general diseases that had a potential to cause peripheral nerve dysfunction were excluded.

Procedure

Herniated discs were surgically treated by APLD in all patients. Postoperative follow-up examinations were performed 62 days to 78 days (mean 68 days) after surgery. Before surgery, motor nerve conduction velocities (MNCV) of the deep peroneal and tibial nerves, and sensory nerve conduction velocities (SNCV) of the superficial peroneal and sural nerves were examined to exclude cases with peripheral nerve lesions. L5 radiculopathy was diagnosed by radicular pain and motor/sensory deficit and confirmed by MRI before operation.

Before and after operation, F-latency and F-persistence of the deep peroneal nerve were measured. Ten supramaximal stimuli were delivered percutaneously to the deep peroneal nerve on the ankle at a rate of 1 Hz. The stimulus duration was set at 0.3 ms, and patients were asked to contract the masseter muscles to enhance the F-wave responses. Only F-waves with an amplitude of 40 μV (peak-to-peak) or more were recorded from the extensor digitorum brevis. A sweep speed of 10 ms/division and a gain of 200 μV were used. F-latency was determined as the minimal latency of the occurring F-response. F-persistence was defined as the percentage appearance of F-responses with respect to the number of stimuli delivered.

The outcome of the operation was evaluated by using the method introduced by Dullerud[9]. The evaluation was based on a combination of resumption of work and social activities, relief of pain, and reduction of dosage of analgesics, and on clinical examination. The following grading was used: very good–complete relief of pain, return to pre-injury functional status, negative straight leg raise test, no or minimal neurologic deficit; good–improved, but incomplete pain relief and/or some residual neurologic deficit, occasionally requiring analgesic medication; unchanged–no improvement; poor–more disabled compared to preoperative status.

Statistics

Wilcoxon signed rank test was employed to compare F-wave characteristics between preoperative and postoperative values. Significance was defined as p values < 0.05 throughout.

RESULTS

All subjects in this study showed improved symptoms after APDL. They were graded either "very good" or "good" in clinical evaluation after operation.

F-latency of the deep peroneal nerve showed a decreasing trend after operation (Fig. 1). F-latencies of the deep peroneal nerve were 46.19 ± 3.58ms and 44.76 ± 2.69 ms preoperatively and postoperatively, respectively (Table 1); however, there was no statistical significance ($p = 0.262$) found.

Our observations in respect to the nature of F-persistence are shown in table 1 and figure 2. The F-persistence of the deep peroneal nerve was found to be 42.5 %± 11.7 % and 66.3 % ± 10.6 % preoperatively and postoperatively, respectively. A statistically significant increase of F-persistence was found postoperatively ($p < 0.05$).

The correlation between outcome and the change of F-persistence was shown in Table2.

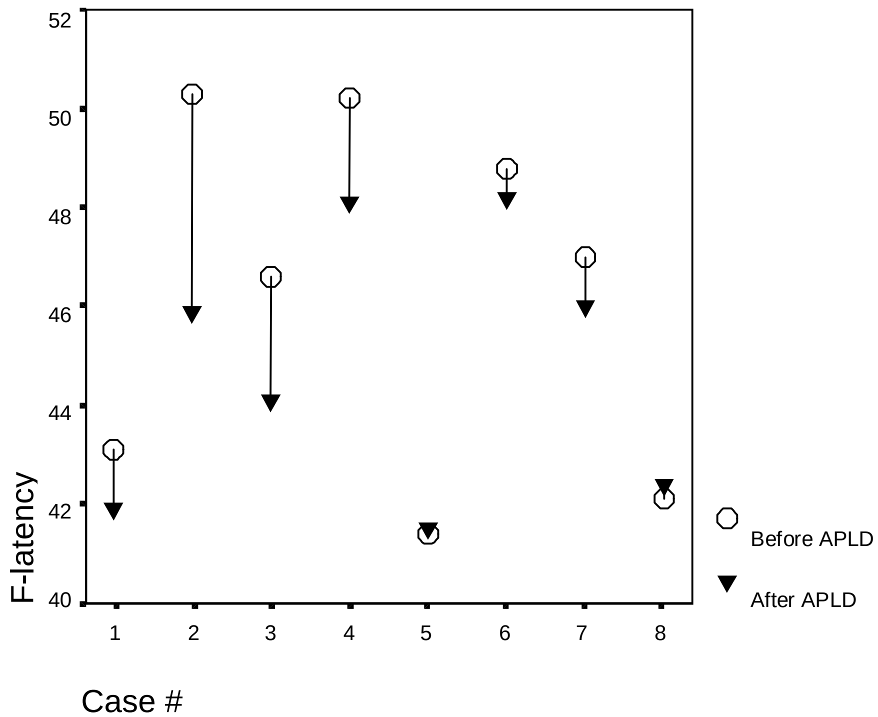

Fig. 1. Changes of F-latency (ms) before and after APLD

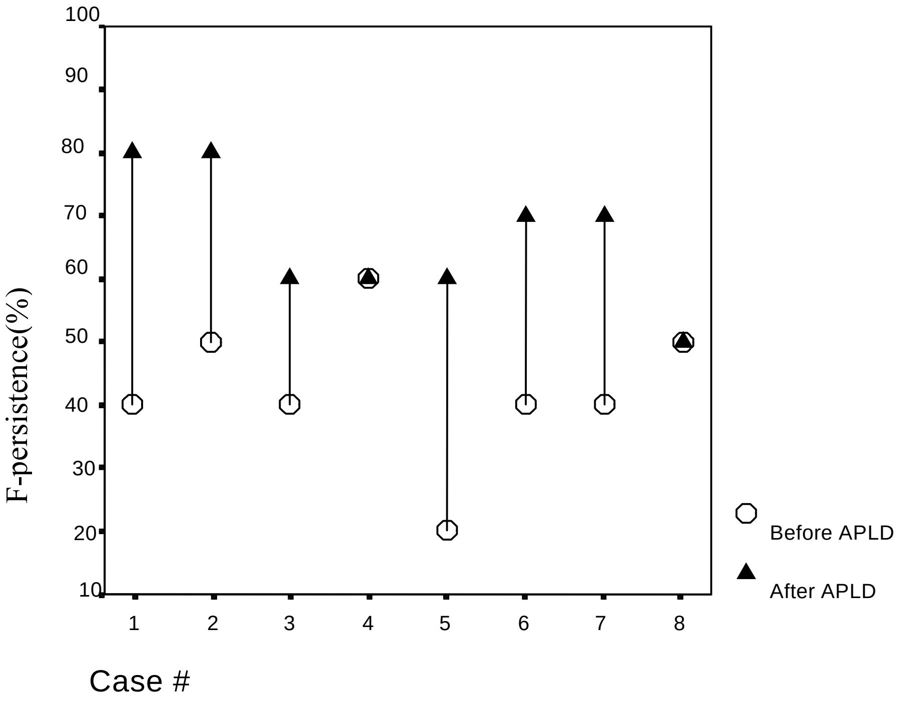

Fig. 2. Changes of F – persistence (%) before and after APLD

Table 1. F-latency and F-persistence before and after APLD

	Mean ± SD		*p* value
	Pre-op	Post-op	
F-latency (ms)	46.19 ± 3.58	44.76 ± 2.69	0.262
F-persistence (%)	42.5 ± 11.7	66.3 ± 10.6	0.020*

Data are expressed as mean ± standard deviation.
APLD = automated percutaneous lumbar disectomy
*significant increase of F-persistence after APLD (p <0.05 , Wilcoxon signed rank test)

Table 2. The outcome and the change of F-wave persistence before and after APLD

Case	outcome	Peroneal F-wave Persistence (%)	
		Pre-op	Post-op
1	very good	40	80 *
2	very good	50	80 *
3	good	40	60 *
4	good	60	60
5	very good	20	60 *
6	very good	40	70 *
7	very good	40	70 *
8	good	50	50

* Significant increase of F-persistence
"very good" means complete relief of pain, return to pre-injury functional status, negative straight leg raise test, no or minimal neurologic deficit; "good" means improvement, but incomplete pain relief and/or some residual neurologic deficit, occasionally requiring analgesic medication.

DISCUSSION

F-wave

The F wave allows the electromyographer to assess motor conduction along the proximal segments of nerves. It is a late muscle potential that results from the backfiring of antidromically activated anterior horn cells. The minimal F-latency, used in this study, represents the shortest time needed for the α-motor neuron fibers to conduct the impulse throughout the antidromic and orthodromic pathway. Whereas, the F-persistence represents the spinal motor neuron excitability. The reappearance of individual motor unit within a series of F-waves is believed to be indicative of the selectivity of motor neuron populations available for F-wave.

In this study, the stimulus duration of the F-wave test was modified. The normal value of F-persistence of the deep personal nerve was 37% ±25% in a previous study by using a duration of 0.2 ms of rectangular electric pulses[10]. This low rate of appearance is not clinical useful. In order to produce a better frequency, we used a stronger stimulation, modified the stimulus duration to 0.3 ms, and contracted the masseter muscles as a facilitating maneuver.

F-latency

Reports of changes of F-latency in patients with lumbosacral radiculopathy are contradictory. Toyokura and Murakami[1] measured F-latency in 100 patients with L5-S1 radiculopathy to examine the sensitivity and characteristics of F-wave abnormalities detected. The results indicated that the sensitivity and specificity of F-latency for radiculopathy were 70% and 100%, respectively. F-latency abnormalities were correlated to neither needle EMG nor clinical findings. They concluded that F-wave study is clinically useful in evaluation of radiculopathy independent of needle EMG or clinical findings. However, F-latency was also reported to be less sensitive in detecting radiculopathy[3,8,11]. Aminoff and coworkers[8] found that only 5 out of 28 patients with radiculopathy had F-latency abnormalities. In the present study, although decreasing tendency was found, there was no significant difference in F-latency before and after the operation. This result implies that the change of the demyelination of the motor neuron might be too small to affect the F-latency. The low sensitivity may be due to the F-latency presenting a slowing conduction of only a small portion of the motor neuron fibers. That is, F-latency may not increase if only a small portion of the motor neuron fibers is affected.

F-persistence

The results of this study show that F-persistence significantly increased after APLD. Voulgaris and coworkers[3] compared F-persistence between 41 patients with L5-S1 radiculopathy and normal subjects. They found that F-persistence of patients with radiculopathy was significantly lower than that of controls. The decreased F-persistence could be explained by a reduced motor neuron excitability because of disruption of the circuit retaining the muscle tone. In this study, the nerve root was decompressed in the patients with radiculopathy after APLD. Motor neuron excitability may be improved after nerve root decompression. The increased F-persistence, therefore, may be explained by increased motor neuron excitability after APLD.

In this study, even though F-persistence and clinical symptoms both improved after APLD, F-latency did not significant decrease. The different result between the F-latency and the F-persistence can be explained by F-latency reflecting only the condition of demyelination of motor neuron. F-persistence, however, can test not only the demyelination of the motor neuron, but also axon loss and dorsal root lesion[12]. Furthermore, because of the low sensitivity of F-latency in detecting demyelination of motor neurons, F-latency might not have decreased with improvement of demyelination after APLD.

Although F-persistence significantly increased and the clinical symptoms improved after APLD in this study, the clinical usefulness of F-persistence in evaluating lumbosacral radiculopathy remains to be determined. Further studies are needed to increase the number of subjects to determine the sensitivity of the F-persistence in detecting radiculopathy. In addition, F-persistence varies in patients with lumbosacral radiculopathies. To correlate the F-persistence to the severity of clinical symptoms before or after operation, a larger number of subjects are needed. The normal range of F-persistence must be established. Furthermore, for assessing the clinical usefulness, both F-persistence and F-latency should be examined immediately before and after operation, and at 3-month and 1-year follow up to assess short-term and long-term changes in F-waves. Finally, to increase the sensitivity of F-persistence, increasing the number of stimuli given to evoke the F-wave may be needed.

In summary, F-persistence significantly increased in patients with L5 lumbosacral radiculopathies after APLD. In addition, the result of F-latency showed a decreasing trend after APLD. The F-wave study may offer additional useful information for detecting the condition or severity of radiculopathy. However, further study is required to determine the role of F-persistence in evaluating the nerve root condition.

CONCLUSIONS

The results of this study showed that F-persistence is more sensitive than F-latency for objective assessment of surgical decompression of L5 radiculopathy. Understanding the role of F-persistence in evaluating the nerve root condition requires further study.

REFERENCES

1. Toyokura M, Murakami K. F-wave study in patients with lumbosacral radiculopathies. Electromyogr Clin Neurophysiol 1997;37:19-26.
2. Toyokura M, Ishida A, Murakami K. Follow-up study on F-wave in patients with lumbosacral radiculopathy. Comparison between before and after surgery. Electromyogr Clin Neurophysiol 1996;36:207-14.
3. Voulgaris AN, Constantinidis TS. F-persistence studies in L5-S1 lumbosacral radiculopathies. Electromyogr Clin Neurophysiol 1996;36:387-93.
4. Grevitt MP, McLaren A, Shackleford IM, et al. Automated percutaneous lumbar discectomy. An outcome study. J Bone Joint Surg 1995;77B:626-9.
5. Teng GJ, Jeffery RF, Guo JH, et al. Automated percutaneous lumbar discectomy: a prospective multi- institutional study. J Vasc Interv Radiol 1997;8:457-63.
6. Johnson EW, Fletcher FR. Lumbosacral radioculopathy: review of 100 consecutive cases. Arch Phys Med Rehabil 1981;62:321-3.
7. Negrin P, Fardin P. Clinical and electromyographical course of sciatica: prognostic study of 41 cases. Electromyogr Clin Neurophysiol 1987;27:125-7.
8. Aminoff MJ, Goodin DS, Parry GJ, et al. Electrophysiologic evaluation of lumbosacral radiculopathies: electromyography, late responses, and somatosensory evoked potentials. Neurology 1985;35:1514-8.
9. Dullerud R, Amundsen T, Lie H, et al. CT-diskography, diskomanometry and MR imaging as predictors of the outcome of lumbar percutaneous automated nucleotomy. Acta Radiol 1995;36:613-9.
10. Zappia M, Valentino P, Marchello LP, et al. F-wave normative studies in different nerves of healthy subjects. Electroencephalogr Clin Neurophysiol 1993;89: 67-72.
11. Eisen A, Hoirch M, Moll A. Evaluation of radiculopathies by segmental stimulation and somatosensory evoked potentials. Can J Neurol Sci 1983;10:178-82.
12. Eisen A, Schomer D, Melmed C. The application of F-wave measurements in the differentiation of proximal and distal upper limb entrapments. Neurology 1977; 27:662-8.

第五腰椎神經根壓迫接受經皮自動腰椎椎間盤切除術患者之 F 波研究

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椎間盤突出併神經根壓迫可能造成 F 波潛期延長及減少 F 波被誘發出來的百分比。

本研究主要是針對第四和第五腰椎間盤突出併第五腰椎神經根壓迫的患者，接受經皮自動腰椎椎間盤切除術(automated percutaneous lumbar disectomy)，手術治療前後深腓神經 F 波的變化進行研究。研究中，共收集 8 名患者，年齡分布由 26 歲至 39 歲，這些患者都有下肢放射痛或運動及感覺的異常而且磁振造影顯示第四第五腰椎間盤突出併神經根壓迫。研究中記錄經皮自動腰椎椎間盤切除術手術前後，深腓神經 F 波潛期和被誘發出 F 波之百分比。爲了使深腓神經的 F 波比較容易被誘發出來，我們對每一病患使用較標準化長之波寬的刺激(0.3 毫秒)和加強的誘發方法(咬合肌緊閉)。研究結果顯示深腓神經 F 波被誘發出來的百分比在術後有顯著增加(術前 42.5±11.7%、術後 66.3±10.6%，$p<0.01$)；F 波潛期雖有縮短的傾向，但仍未達統計上明顯差異(術前 46.19±3.58ms、術後 44.76±2.69ms，$p=0.262$)。F 波被誘發出來百分比的增加，可能可以解釋爲神經根壓迫的壓力減輕後，神經較容易被興奮。而 F 波潛期縮短較不明顯，可能原因是因爲 F 波只反應一小部分傳導最快的神經纖維表現，所以比較沒有那麼敏感。

本研究的結果顯示，以 F 波來評估病人接受經皮自動腰椎椎間盤切除術，去神經根壓迫手術前、後之變化，F 波的誘發百分比比 F 波潛期更具敏感度，有關 F 波誘發百分比對神經根病變檢查之價值，值得再作更深入之研究。（中華復健醫誌 2000; 28(4): 213 - 219）

關鍵詞： F 波持續率(F-persistence)，F 波潛期(F-latency)，
經皮自動腰椎椎間盤切除術(automated percutaneous lumbar disectomy)

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