Original Article / *Klinik Çalışma - Araştırma*

Relationship Between Clinical and Needle Electromyography Findings in Patients With Myotomal Muscle Weakness Caused by Cervical Disk Herniation: A Long-Term Follow-Up Study[*]

Servikal Disk Hernisi Kaynaklı Myotomal Kas Güçsüzlüğü Olan Hastalarda Klinik ve İğne Elektromiyografi Bulgularının İlişkisi: Uzun Dönem İzlem Çalışması

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Objectives: In this study, we aimed to identify the course of radiculopathy and long-term functional outcomes in non-surgically treated patients with myotomal muscle weakness caused by cervical disk herniation.

Patients and Methods: Twenty-three patients (15 males, 8 females; mean age 40.7±7.3 years; range 27 to 55 years) were included in the study. Patients were treated with specific physical therapy and rehabilitation programs. Clinical and electrophysiological evaluation were done at the beginning, every four months within the first year, and every year after two years. All patients completed 24 months, and 19 patients completed 36 months of follow-up.

Results: In 12 (52%) patients, needle electromyography (EMG) findings returned to normal at the second EMG examination. Only four (21%) patients had abnormal EMG findings at the end of the study period. In 13 (56%) patients, muscle strength became normal within four months, and it became normal in 17 (74%) patients within the first year. Progressive muscle weakness was not observed in any patient during the study. At the end of the study, excellent or good functional outcome were obtained in 15 (79%) patients.

Conclusion: Myotomal muscle weakness resulting from cervical disk herniation is usually caused by a neuropraxic lesion at the root level. Patients with axonal root injury also have high potential for recovery, due to multilevel innervation of upper extremity muscles.

Key Words: Cervical disk herniation; radiculopathy; myotomal muscle weakness; needle EMG.

Amaç: Bu çalışmada servikal disk hernisi kaynaklı myotomal kas güçsüzlüğü olan ve cerrahi dışı yöntemlerle tedavi edilen hastalarda radikulopatinin seyrini ve uzun dönem fonksiyonel sonuçlarını belirlemeyi amaçladık.

Hastalar ve Yöntemler: Çalışmaya 23 hasta (15 erkek, 8 kadın; ort. yaş 40.7±7.3; dağılım 27-55) dahil edildi. Hastalar spesifik fizik tedavi ve rehabilitasyon programları ile tedavi edildi. Klinik ve elektrofizyolojik değerlendirmeler çalışma başlangıcında, ilk yıl içerisinde dört ayda bir, sonraki iki yılda ise yılda bir olarak yapıldı. Tüm hastalar 24 ay, 19 hasta ise 36 aylık izlem süresini tamamladı.

Bulgular: On iki hastada (%52) iğne elektromiyografi (EMG) bulguları ikinci EMG incelemesinde normale döndü. Çalışma sonunda ise sadece dört hastada (%21) anormal EMG bulguları vardı. Kas gücü 13 hastada (%56) dört ay içerisinde normale dönerken, 17 hastada (%74) ise ilk yıl içerisinde normale döndü. Çalışma süresince herhangi bir hastada ilerleyici güç kaybı gözlenmedi. Çalışma sonunda 15 hastada (%79) mükemmel ya da iyi bir fonksiyonel sonuç elde edildi.

Sonuç: Servikal disk hernisi nedeniyle gelişen myotomal kas güçsüzlüğü genelde kök seviyesinde nöropraksik bir lezyondan kaynaklanmaktadır. Üst ekstremite kaslarının birden fazla seviyeden innerve olmaları nedeniyle aksonal kök hasarı tespit edilen hastalar dahi yüksek bir iyileşme potansiyeline sahiptir.

Anahtar sözcükler: Servikal disk hernisi; radikülopati; myotomal kas güçsüzlüğü; iğne EMG.

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Radiculopathy caused by cervical disk herniation (CDH) is a common problem. It usually causes pain, sensory disturbances, loss of reflexes and, less frequently, muscle weakness in the myotomal distribution.[1,2]

Cervical radiculopathies are among the commonest causes of referral to the neurophysiology laboratory. Electrophysiological tests together with imaging are frequently used in the evaluation of radicular pain, primarily for confirming or excluding radiculopathy, and for identifying the severity of root dysfunction. Magnetic resonance imaging (MRI) seems to have reduced the need for electrodiagnostic tests for showing compression of the spinal root, but it does not give information about the physiologic integrity and functions of the nerve root.[1,3] Electromyography (EMG) findings can be used for deciding if surgery is indicated in these patients.

Some patients have definite indications for surgery, such as myelopathy and progressive muscle weakness, but most do not. Even patients with non-progressive motor deficit are treated surgically immediately or after minimal intervention. A widely accepted treatment strategy for these patients has not been agreed. There have been many studies regarding surgical techniques of CDH, but only one study compared long-term functional outcomes of surgical and non-surgical treatments.[4,5]

The aim of the present study was to investigate the nature and course of root dysfunction and myotomal muscle weakness caused by CDH and long-term functional outcomes of non-surgical treatment.

PATIENTS AND METHODS

Twenty-three consecutive patients (15 males, 8 females; mean age 40.7±7.3 years; range 27 to 55 years) with myotomal muscle weakness caused by acute CDHs who refused surgical intervention were included in the study. Inclusion criteria included a focal acute cervical disk protrusion and root compression confirmed with MRI and myotomal muscle weakness compatible with cervical radiculopathy. Exclusion criteria were multilevel CDHs, myelopathy, weakness in more then one myotome, previous cervical surgery, cervical or brachial plexus trauma, and serious spondylotic changes.

Patients were treated with oral medication (analgesics, non-steroidal anti-inflammatory drugs, corticosteroids), specific physical therapy and rehabilitation programs defined by the treating physician. Physical therapy programs included a combination of moist heat, therapeutic ultrasound, transcutaneous electrical nerve stimulation, massage, intermittent cervical traction, electrical muscle stimulation and progressive resistive exercises for weak muscles. Patients were asked to continue the exercise program at home after cessation of physical therapy. Patients were advised regarding appropriate positioning of the neck, and avoidance of movements that may exacerbate symptoms.

Patients were evaluated by an investigator other than the treating physician. Neurophysiologic examination was done by the same investigator. Before treatment, detailed clinical examination was carried out. Clinical examination included evaluation of pain at rest and during movement, muscle weakness, and superficial sensory symptoms (paresthesia/hypoesthesia). When evaluating pain, patients were asked to define their pain by using a ten-point visual analog scale (VAS) for rest and while performing the Spurling test (extending the neck, rotating to the side of the pain and applying downward pressure). A five-grade manual muscle test scale was used for evaluating muscle weakness. External rotation of the shoulder, shoulder abduction, elbow flexion, elbow extension, forearm pronation, wrist flexion, wrist extension, extension of the second finger, and thumb and little finger abduction strength were determined. Clinical examination was done by the same investigator before treatment and 4, 8, 12, 24 and 36 months after initial examination.

Electromyographic examinations were done at least three weeks after symptom onset. At initial electrophysiological examination, nerve conduction studies, needle EMG of extremity

Table 1. Needle electromyography findings of key muscle groups during the study period

Needle EMG findings	Initial	4 months	8 months	12 months	24 months	36 months
Normal	0	12	17	17	19	15
Reduced recruitment	16	2	0	0	0	0
Reduced recruitment + PSW and fibrillation	7	4	2	2	0	1
Chronic denervation	0	5	4	4	4	3
Total	23	23	23	23	23	19

EMG: Electromyography; PSW: Positive sharp waves.

muscles (infraspinatus, deltoid, biceps, triceps, pronator teres, extensor carpi radialis longus/brevis, extensor indicis proprius, extensor digitorum communis, abductor pollicis brevis, abductor digiti minimi) and paraspinal muscles (C5-T1) were done for the involved side. A key muscle group was identified for each myotome. The following were accepted as key muscle groups: C5 (root infraspinatus and deltoid); C6 (root deltoid, biceps and pronator teres); and C7 (root triceps, extensor indicis proprius and extensor digitorum communis). Electromyographic studies were carried out together with clinical examination during the follow-up period. Only the muscles of related myotomes were re-explored on subsequent EMG investigations. Membrane instability (positive sharp waves (PSWs), fibrillation potentials), increased polyphasia, and increase of amplitude and duration of motor units were accepted as pathological findings of radiculopathy. When evaluating long-term outcomes, patients were divided into three groups. Outcome was considered excellent if a patient had no signs or symptoms of radiculopathy and no pathological EMG findings. Outcome was considered good if patients had minor pain with VAS scores of ≤3 and no muscle weakness. Outcome was considered poor if a patient had muscle weakness with or without other signs or symptoms of radiculopathy, or VAS scores of ≥4 at rest or for the Spurling test. Patients were asked their worst pain score between control examinations for recurrence of symptoms, and also their need for therapy.

The study was done in accordance with the Helsinki Declaration and informed consent was obtained from the subjects.

RESULTS

All patients completed 24 months of follow-up; and 19 patients completed 36 months of follow-up. Mean symptom duration was 12.2±7.5 days.

In 16 patients (69%), only reduced recruitment of motor units was found without denervation potentials at initial needle EMG examination. In seven patients (31%), in addition to reduced recruitment of motor units, PSWs and fibrillation potentials were also found. Needle EMG findings were normal in 12 patients at the second examination. Only four patients had abnormal EMG findings at the end of the study period (Table 1).

At initial EMG examination, PSWs and fibrillation potentials were found in extremity and paraspinal muscles in three patients, and in only the paraspinal muscles in four patients. After two years, PSW and fibrillation potentials were not found in any muscle. In the last evaluation, one patient had PSWs and fibrillation potentials of mild degree only in the extremity muscles.

During follow-up, all control mean VAS scores were significantly lower than initial VAS scores ($p<0.000$) at rest and pain during the Spurling test. After 12 months, there was no significant difference between evaluation at 12 months and further control examinations for rest and Spurling test pain ($p>0.05$; Fig. 1).

Muscle strength returned to normal within four months in 13 patients (56%); within the first year in 17 patients (73%); within two years in 19 patients (83%); and after three years (four patients gave up study) in 15 patients (79%). Progressive muscle weakness was not

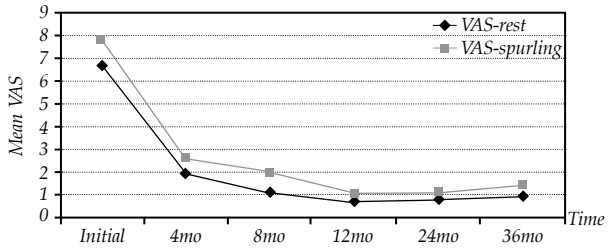

Fig. 1. *Changes of mean rest and Spurling test VAS scores of patients during the study period.* *VAS: Visual analog scale.*

observed in any patient during the study (Fig. 2). Recovery from muscle weakness was not different for 4 (p=0.154), 12 (p=0.72), 24 (p=0.79) and 36 (p=0.71) months of evaluation between patients with neuropraxic root lesions and with axonal injury.

Paresthesia/hypoesthesia were related to dermatoms in 15 patients (65%) at initial examination. The number of patients with superficial sensory symptoms progressively decreased during the study period (Fig. 3).

No patient needed surgery due to myelopathy, progressive muscle weakness or intractable pain. Five patients (21%) described serious recurrence of pain with VAS scores of >5 between control examinations, but they defined their pain as being less than in their first attack. Four patients repeated the physical therapy program due to recurrence or insufficiently recovered pain during the follow-up period.

At the end of 24 months, 11 patients (48%) had excellent outcome without signs or symptoms of radiculopahy and no needle EMG findings. Eight patients (35%) had good outcomes, and four patients (17%) had poor outcomes. At the end of the study, 15 patients (79%) had excellent or good outcomes (Table 2). Only four patients had poor outcomes due to unrecovered muscle weakness; two of them had clinically observed muscle atrophy at the end of the study period.

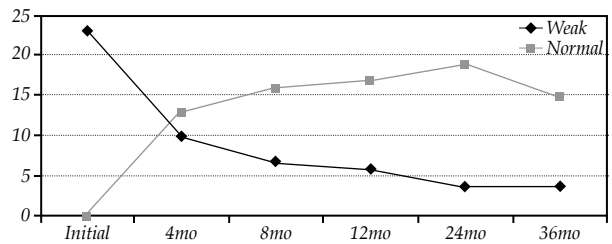

Fig. 2. *Number of patients with normal and myotomal muscle weakness during the study period.*

DISCUSSION

Most CDHs are managed non-surgically, but there are few studies exploring the outcomes of such treatment.[1,5-7] There are many studies regarding the surgical techniques of CDHs, but most do not investigate long-term outcomes. In the present study, we followed up patients for 2-3 years, and also used needle EMG for evaluation of the nature and course of root dysfunction.

Needle EMG is the most sensitive neurophysiologic test for evaluating radiculopathy. It provides information on diagnosis, location and prognosis.[8,9] If a root is affected, three main disorders occur at the root level: conduction slowing, conduction block and axonal death. The latter two are responsible for myotomal muscle weakness to some degree.[10] Conduction block (neuropraxic lesion) has a good prognosis and recovery is very likely; axonal death causes Wallerian degeneration, recovery may be incomplete and takes longer. In the present study, seven patients have PSWs and fibrillation potentials compatible with axonal injury, and 16 patients had only reduced recruitment in maximal voluntary contraction, which represents a neuropraxic lesion at the root level. Czyrny and Lawrence[11] reported that PSWs and fibrillation potentials are restricted solely to the paraspinal muscles in 40% of cervical radiculopathies. In our study, PSWs and fibrillation potentials were limited to the paraspinal muscles in only four patients (17%).

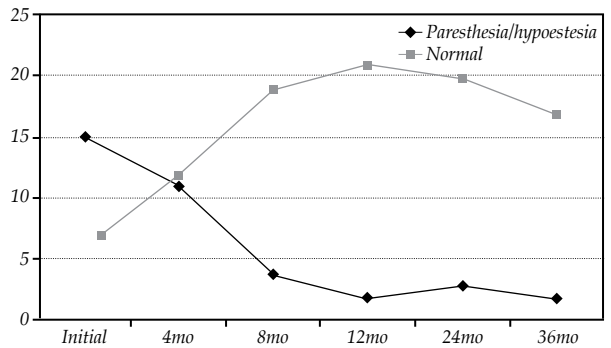

Fig. *3. Number of patients with superficial sensory symptoms during the follow-up period.*

Table 2. Initial clinical findings of all patients and functional outcomes for 24 months and 36 months

Patient number	Age (years)	Side	Affected root	Weakness	Muscle strength	Sensory changes	Outcome 24 mo	Outcome 36 mo
1	35	R	C7	Elbow extension	3/5	+	E	E
2	43	R	C7	Wrist/finger extension	4/5	+	E	E
3	27	L	C6	Elbow flexion	4/5	+	G	G
4	29	L	C7	Elbow extension	4/5	–	P	P
5	51	L	C7	Elbow extension	4/5	+	E	E
6	47	R	C6	Shoulder abduction	2/5	+	G	P
7	43	R	C5	Shoulder abduction	3/5	–	P	G
8	32	R	C6	Elbow flexion	4/5	+	G	G
9	39	R	C7	Elbow extension	4/5	+	G	Ø
10	43	L	C6	Shoulder abduction	3/5	–	E	E
11	46	R	C7	Elbow extension	4/5	+	E	E
12	39	L	C7	Elbow extension	4/5	+	G	G
13	52	R	C7	Elbow extension	3/5	+	G	G
14	55	L	C6	Elbow flexion	4/5	–	E	Ø
15	43	L	C6	Shoulder abduction	3/5	–	G	E
16	34	R	C7	Elbow extension	4/5	+	E	E
17	37	L	C7	Elbow extension	4/5	+	E	E
18	40	R	C6	Elbow flexion	4/5	–	E	Ø
19	49	L	C6	Elbow flexion	4/5	+	G	G
20	37	L	C7	Elbow extension	4/5	+	P	P
21	34	R	C6	Shoulder abduction	3/5	+	E	Ø
22	38	R	C7	Elbow extension	4/5	+	E	E
23	43	L	C7	Elbow extension	4/5	+	P	P

E: Excellent; G: Good; P: Poor; Ø: Gave up study.

Myotomal muscle weakness was directly related to EMG findings during the study period. At the end of 24 months, 19 out of 23 patients had no EMG findings and no muscle weakness, compared with 15 out of 19 patients at the end of 36 months. Recovery from muscle weakness for neuropraxic root lesions seemed to be faster than for patients with axonal injury for the first four months, but this difference was not statistically significant.

C6 and C7 radiculopathies constitute nearly 85-94% of cervical radiculopathies.[12,13] In our study, C7 was the most affected root (56%) followed by C6 (39%). Shoulder abductors were the weakest muscle groups in four patients with C6 radiculopathy. Elbow flexors were to the weakest muscle groups in five patients with C6 radiculopathy. Elbow extensors were the weakest muscle group in almost all patients with C7 radiculopathy. This may be related to individual differences in innervation of the extremity muscles.[14] At the end of the study, four patients had muscle weakness at 4/5 degree with chronic denervation and reinnervation findings in needle EMG. All upper extremity muscles have multilevel innervation, so even complete root dysfunction will not cause total paralysis of the related muscles. Moreover, our EMG findings showed that most root injuries were neuropraxic lesions, which have good recovery potential. Progressive motor weakness or myelopathy, which are widely accepted as definite indications for surgery, were not observed during the study period.

Almost all patients had lower VAS scores compared to initial VAS scores. Only four patients needed to repeat the physical therapy program and medications during follow-up. Persson et al.[5] compared surgery, physical ther-

apy and the cervical collar; they found that the surgery group reported less pain, less sensory loss and had better muscle strength for four months of control examination but there were no significant differences between groups for these parameters after a further year. In our study, most patients did not show improvement after 12 months. This finding may suggest that recovery from radiculopathy takes nearly one year after onset.

We evaluated only the existence or absence of superficial sensory symptoms. Quantification of hypoesthesia is unreliable, and it is well known that some patients have paresthesias. The number of patient with superficial sensory symptoms progressively decreased during the study, parallel to recovery of muscle weakness.

Only patients with acute disk herniations of one cervical level were included in the study. So our study group was very homogenous. There are many patients with multilevel disk herniations or chronic disc disease. This may be a limitation of our study.

At the end of 24 months, 19 patients (83%) had good or excellent outcomes; at the end of 36 months, 15 patients (79%) had good or excellent outcomes. Saal et al.[7] reported that 24 out of 26 patients were treated successfully with aggressive non-surgical therapy. In a study from Lipets et al.[15] in which seven patients with painless radicular weakness were evaluated, a high rate of good recovery was reported. Persson et al.[5] found no difference between surgery and physical therapy groups in terms of pain, muscle weakness and sensory loss at the end of one year. DePalma and Subin[6] compared surgery and conservative treatment outcomes in 255 patients, and reported a higher rate of complete relief (64%) compared with the conservative group (29%). In many studies, spontaneous regression of disk herniation was shown.[16,17] Mochida et al.[17] reported that lateral-type herniations have a high regression rate and conservative treatment is successful even in patients with myotomal weakness.

In conclusion, myotomal muscle weakness due to CDHs represents mainly a neuropraxic lesion at the compressed root segment, and the potential for recovery is good. Patients with denervation findings on EMG also have a good prognosis, possibly due to multilevel innervation of upper extremity muscles. These patients can be treated conservatively with close monitoring; early surgery should be avoided.

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