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Original Investigation

# Electrophysiological Findings in Patients with Adult Tethered Cord Syndrome

## Yetişkin Tethered Kord Sendromlu Hastalarda Elektrofizyolojik Veriler

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### ABSTRACT

**AIM:** This study was planned for detailed evaluation of electrophysiological findings in patients with adult TCS.

**MATERIAL and METHODS:** Patients were retrospectively assessed for clinical, radiological and electrophysiological data between 1999 and 2008. Tibial somato-sensorial evoked potentials, needle electromyography, nerve conduction studies and late responses (H reflex and F response) were studied in thirty (1 female, 29 males) TCS patients diagnosed by lumbar magnetic resonance imaging.

**RESULTS:** Tibial somato-sensorial evoked potentials cortical response latency was abnormal in 18 (60%) patients. Needle electromyography revealed chronic neurogenic involvement in 13 (43.3%) patients. In nerve conduction studies, motor unit action potential amplitudes were reduced in 5 (16.6%) patients and H reflexes were abnormal in 13 (43.3%) patients.

**CONCLUSION:** Different electrophysiological abnormalities may be seen in patients with adult TCS. Our results indicated that tibial SEP abnormalities are most sensitive electrophysiological finding in patients with adult TCS. Patients with TCS should undergo electrophysiological examinations whether they have subjective or objective complaints. These examinations should evaluate different systems and treatment planning should be done with the data obtained.

**KEYWORDS:** Tethered cord syndrome, Somato-sensorial evoked potentials, Needle electromyography, Nerve conduction study, Late responses, Electrophysiology

### ÖZ

**AMAÇ:** Bu çalışma, yetişkin TKS'lu hastalarda elektrofizyolojik bulguların ayrıntılı değerlendirilmesi amacıyla planlandı.

**YÖNTEM ve GEREÇ:** 1999 ile 2008 yılları arasında incelenen hastalar retrospektif olarak klinik, radyolojik ve elektrofizyolojik bulgularıyla değerlendirildi. Lomber magnetik rezonans görüntüleme ile TKS tanısı konulan 30 (1 kadın, 29 erkek) hastada tibial somatosensoryel uyarılmış yanıtlar, iğne elektromiyografi, sinir iletim ve geç yanıtlar (H refleks ve F yanıtları) çalışıldı.

**BULGULAR:** Somatosensoryel uyarılmış yanıt incelemesinde hastaların 18'inde (%60) kortikal yanıt latans anormalliği izlenmiştir. İğne elektromiyografi incelemesinde 13 (% 43,3) hastada kronik nörojenik tutuluşla uyumlu bulgular vardı. Sinir ileti incelemelerinde 5 (%16,6) hastada motor ünit aksiyon potansiyel amplitüdü azalmış bulundu ve 13 (% 43,3) hastada H refleks anormallikleri izlendi.

**SONUÇ:** Yetişkin TKS'lu hastalarda farklı elektrofizyolojik anormallikler görülebilir. Bizim sonuçlarımız göstermiştir ki yetişkin TKS'lu hastalarda tibial SEP anormallikleri en duyarlı elektrofizyolojik bulgudur. TKS'lu hastalar, ister sübjektif, ister objektif şikâyetleri olsun elektrofizyolojik olarak da değerlendirilmelidir. Bu incelemeler farklı sistemleri kapsayacak şekilde planlanmalı ve tedavi planlaması elde edilen verilerle birlikte yapılmalıdır.

**ANAHTAR SÖZCÜKLER:** Tethered kord sendromu, Somatosensoryel uyarılmış yanıtlar, İğne elektromiyografi, Sinir iletim çalışması, Geç yanıtlar, Elektrofizyoloji

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## INTRODUCTION

Tethered cord syndrome (TCS) is most often seen during childhood, although the condition may persist or begin in adulthood (1,4). The terminal portion of the spinal cord, the conus medullaris, exists below the level of L2. Patients with TCS often present with symptoms secondary to a thickened filum terminale. However, these symptoms may also occur in the presence of a normal appearance of the filum terminale (8). TCS causes caudal traction of the spinal cord and it is different from the lesions in the cervical region which cause traction of the cervical segments (3). TCS may be found as a co-morbidity associated with the currarino triad, myelomeningocele, syringomyelia, diastematomyelia and intra or extradural lipoma which may exacerbate the clinical findings (1, 2, 5). The most common complaints in adult TCS cases are back pain, bladder dysfunction and leg pain (4), which may be hard to differentiate from lumbar disc disease (11).

The current standard for diagnosis is magnetic resonance imaging (MRI) and criteria for diagnosis via electrophysiological methods do not exist. The aim of this study was to investigate the availability of electrophysiological data in order to develop follow-up and treatment protocols for patients diagnosed with TCS by MRI.

## MATERIAL and METHODS

Patients diagnosed with TCS who were admitted to Gülhane Military Medical Academy Department of Neurology for electrophysiological studies [(electromyography (EMG), nerve conduction study (NCS), late responses and somato-sensorial evoked potentials (SEP)] from June 1999 through December 2008 were identified. Thirty patients were included in the study (1 female, 29 male). Diagnoses were made by MRI. The mean age was 22 ± 4.9 years. A Dantec Keypoint 4-channel EMG device was used for electrophysiological studies.

The protocol for the SEP consisted of stimulation to the tibial nerve posterior to the medial malleoli. Surface electrodes were used for recording the somato-sensory evoked potentials. Both thoracal and cortical potential latency and thoraco-cortical tibial SEP conduction time were separately measured on the left and right tibial nerves. To stimulate tibial nerve for a cortical response, an active electrode was placed 2 cm on the back of vertex, and a reference electrode was placed on the midline frontal region hairy skin. To measure the peripheral response, an active electrode and a reference electrode were placed on the 12th thoracic vertebra and the anterior superior iliac spine, respectively.

Nerve conduction studies (bilateral peroneal and tibial motor nerve, sural sensory nerve) and late responses (F-wave and H-reflex) were studied by standard conduction techniques in all patients. Needle EMG was performed in L4, L5 and S1 myotomes bilaterally using concentric needle electrodes.

## RESULTS

Twenty-one patients (70%) complained of back pain and 11 (36.6%) complained of leg pain. Three patients had weakness in ankle plantar and dorsal flexion unilaterally. Unilateral foot deformity was observed in one patient (Figure 1). Fecal incontinence was seen in 3 (10%) patients. One patient who had split cord malformation and congenital block vertebrae in the lumbar region presented with acute renal failure (Figure 2A,B,C).

*Somato-sensory evoked potential responses:*

Tibial SEPs were abnormal in 18 patients with 9 presenting prolonged cortical latencies bilaterally and 9 unilaterally. Peripheral responses were normal in all patients

***Figure 1:*** *Comparison of the feet in a patient with tethered cord syndrome.*

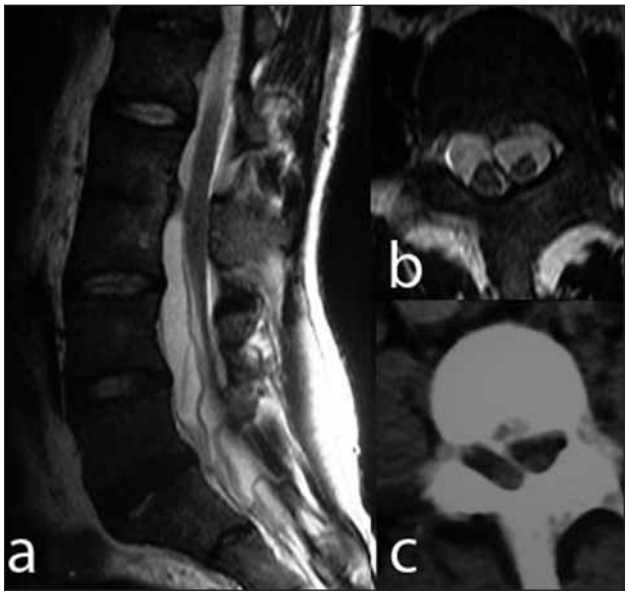


***Figure 2:*** *Tethered cord syndrome, split cord malformation and congenital block vertebrae in a patient who presented with acute renal failure.* ***A****) T1 weigted sagittal MRI,* ***B****) T1-weigted axial MRI,* ***C****) axial computerized tomography showing split cord malformation at L1 level.*

*Needle EMG:*

No patient had denervation potentials. Needle EMG revealed chronic neurogenic involvement in L5-S1 myotomes in 13 patients, with 9 presenting with bilateral impairment.

*Nerve conduction studies and late responses:*

Peroneal and tibial motor nerves and sural sensory nerve conduction studies were performed bilaterally in addition to bilateral H-reflex and F-response analysis.

All patients had normal sural nerve conduction studies. Peroneal motor conduction studies showed heavy axonal loss in 5 patients, although the remaining patients all demonstrated normal peroneal and tibial motor nerve conduction studies. F-response latencies were prolonged in 4 patients and thirteen patients had pathologic H-reflexes recorded from gastrocnemius muscle (Table I).

*Lumbosacral MRI studies:*

Conus medullaris existed at the levels of L4 and L5 in all patients. Thickened terminal filum was found in all patients, including a myelomeningocele in 14 patients and split cord malformation in 5 patients.

## DISCUSSION

Although symptoms related to TCS occur most commonly in childhood, adults may also present with symptoms of the disorder. The most common clinical symptoms are low back pain, leg pain and bladder dysfunction (4). Lumbar MRI is the current gold standard for diagnosis. Surgical treatment options are available to reduce functional impairments and pain, although patients often opt for conservative treatment to manage the symptoms. The need for surgical management of adulthood TCS is debatable and no clear criteria have been established to select appropriate surgical candidates or monitor surgical success. Adults with TCS should undergo an electrophysiological evaluation as detailed. If surgery is opted for, the data from this evaluation should be used in the decision process.

Studies evaluating electrophysiological findings in spinal pathologies such as spinal dysraphisms are generally performed in childhood. Electrophysiological assessment usually consists of preoperative and postoperative findings (9, 10). While electrophysiological findings in adult TCS patients have been evaluated, these studies consist mainly of intraoperative assessments (6, 7). Few studies have performed a detailed electrophysiological assessment in non-operated patients with TCS in adulthood.

Each of the parameters used for electrophysiological examinations evaluate different systems. This increases the likelihood that comprehensive neurophysiological evaluation will determine the pathological system. Central and peripheral sensory pathways can be evaluated by tibial SEP studies, anterior roots of the spinal nerves can be evaluated by examining specific myotomes with needle EMG and motor and sensory pathways can be evaluated by separate nerve conduction studies in peripheral nerves. Motor and sensory functions of peripheral nerves, anterior and posterior nerve roots and their central connections can be evaluated separately with this detailed electrophysiological assessment.

Our work includes a small number of patients but provides an important foundation for evaluating adults with TCS symptoms. It is apparent from these results that TCS may damage various central and peripheral pathways. The data obtained from electrophysiological testing may be important in the treatment planning of patients. We found that 13

**Table I:** Summary of Electrophysiological findings.

| Case | EMG | NCS | H reflex | Tibial SEP |
|---|---|---|---|---|
| Case 1 | N | N | N | Bl-↑ |
| Case 2 | CL-NR (L5-S1) | N | ↑ | Bl-↑ |
| Case 3 | N | N | N | R- ↑ |
| Case 4 | N | MUAP ↓ , F ↑ | ↑ | R- ↑ |
| Case 5 | N | N | N | N |
| Case 6 | N | N | N | L- ↑ |
| Case 7 | CL-NR (L5- S1) | N | ↑ | L- ↑ |
| Case 8 | CL-NR (L5-S1) | MUAP ↓ , F ↑ | ↑ | Bl-↑ |
| Case 9 | CL-NR (L5-S1) | MUAP ↓ | ↑ | Bl-↑ |
| Case 10 | N | N | N | N |
| Case 11 | N | N | N | L- ↑ |
| Case 12 | N | N | N | N |
| Case 13 | N | N | N | N |
| Case 14 | CL-NR (L5-S1) | N | ↑ | L- ↑ |
| Case 15 | CL-NR (L5-S1) | N | ↑ | N |
| Case 16 | N | N | N | N |
| Case 17 | CL-NR (L5-S1) | N | ↑ | N |
| Case 18 | N | N | N | N |
| Case 19 | CL-NR (L5-S1) | MUAP ↓ , F ↑ | ↑ | Bl-↑ |
| Case 20 | N | N | N | L- ↑ |
| Case 21 | N | N | ↑ | Bl-↑ |
| Case 22 | N | N | N | N |
| Case 23 | CL-NR (L5-S1) | N | ↑ | Bl-↑ |
| Case 24 | CL-NR (L5-S1) | N | N | Bl-↑ |
| Case 25 | CL-NR (L5-S1) | N | N | N |
| Case 26 | CL-NR (L5-S1) | MUAP↓ , F ↑ | ↑ | L- ↑ |
| Case 27 | N | N | N | Bl-↑ |
| Case 28 | N | N | N | L- ↑ |
| Case 29 | N | N | N | N |
| Case 30 | CL-NR (L5-S1) | N | ↑ | N |

MUAP↓: Muscle Action Potential Amplitude reduced (Peroneal nerve)

F ↑: F response latency prolonged

CL-NR: Chronic Lesion of Nerve roots (L5-S1)

Bl-↑: Bilaterally prolonged

R- ↑: Prolonged on the right side

L- ↑: Prolonged on the left side

NCS: Nerve conduction study

EMG: Needle electromyography

(43.3%) patients had findings compatible with chronic neurological involvement in needle EMG with in 9 (30%) presenting with bilateral involvement. H-reflex abnormalities were monitored in 13 (43. 3%) patients. Tibial SEP cortical response latencies were prolonged in 18 (60%) patients. Our results indicated that tibial SEP abnormalities are the most sensitive electrophysiological finding in patients with adult TCS.

In conclusion, different electrophysiological abnormalities are seen in patients with adult TCS. These patients should undergo electrophysiological examinations whether they have subjective or objective complaints. This examination should not be restricted to needle EMG and a more detailed and combined neurophysiological analysis should be made. The affected systems can be identified through a comprehensive evaluation and utilized in accurate treatment planning.

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