

# Examination of The Predictive Power of Electromyography and Urodynamic Study in Patients with Cauda Equina Syndrome (Horse Tail Syndrome)

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## ABSTRACT

**Background:** Cauda equina syndrome is a rare disorder that causes loss of Lumbar plexus function (nerve roots) lower than conus medullaris. No risk factor has been defined for this disease yet. Due to the high morbidity of Cauda equina syndrome and lack of sufficient information about the connection between the disease and urodynamic findings and EMG (Electromyography) findings, the need for this comprehensive study is felt. **Objective:** The aim is to determine the predictive power of findings resulted from urodynamics and electromyography of perineal region and around sphincter in the clinical cure rate of urination in patients with urinary retention followed by Cauda equina syndrome. **Method:** Patients referred to Shohadaye Tajrish Hospital during the years 2009 to 2013, in case of having Cauda equina syndrome symptoms (confirmed with Lumbar MRI), were undergone urodynamic examination and perineal electromyography after surgical decompression action. These both assessments (urodynamic study and electromyography) were repeated during the follow-up of 15 patients in the first and sixth months after surgery and findings were compared with each other. **Results:** Among the Urodynamic findings, Qmax (maximum urine flow) during three studies had a significant relationship with long-term recovery rate of patients ( $P < 0.05$ ). The relationship had been more valuable in follow-ups after one month ( $P = 0.0001$ ). Also, BCI (Bladder Contractility Index) in all three studies had a significant relationship with clinical improvement in the ability to urinate ( $P < 0.001$ ). The residual urine (PVR) compared to two previous urodynamic findings showed a less significant relationship with clinical cure rate ( $P = 0.04$ ). Among the findings of muscle-nerve (MUAP Fibrillation, Positive sharp way) none of them had a significant relationship with cure rate. **Conclusion:** Urodynamic finding, especially Qmax and bladder contractility index, can be considered as predictive indicators for patients' recovery after surgery.

**Key words:** Cauda equina syndrome, Urodynamic study, Electrodiagnosis.

## 1. INTRODUCTION

Cauda Equina Syndrome or CES is a rare syndrome and one of the neuro-surgical emergencies that occurs due to damage to Cauda Equina and leads to lumbar plexus function (nerve roots) lower than conus medullaris (1). Spinal cord contains S1-5, L1-5 nerve roots after conus medullaris. S4-L4 roots come together in sacral plexus that affect the sciatic nerve that go to the legs and any pressure or trauma or any other damage cause symptoms (2). The syndrome can also occur due to spinal stenosis followed by chronic tuberculosis, chronic inflammatory Paget disease, Ankylosingspondylitis, polyneuropathy and demyelination (3). No specific risk factor has been defined for this disease yet; however it can be occurred by herniated disk significantly

(4). The prevalence of the syndrome is 3 to 4 people per million (5) and in black race patients less than others. It is more common in men than in women and the average age of onset is middle age that according to the activities that most people do at this age, like lifting heavy things, it is in this age group (6, 7). Cauda equina syndrome causes some symptoms such as weakness in the muscles of the lower limbs that shows itself as paraplegia and detrusor weakness that causes urinary retention and incontinence. It also impacts on the anal muscles and causes fecal incontinence, impotence and insensibility in the saddle area. Acute symptoms of this syndrome include pain in the leg and severe back pain and strict sense changes in saddle shaped area (genitals, urethra, anus, inner thighs) like urinary

retention and incontinence that need for hospitalization (8-11). This syndrome is classified into two types of complete (or CES with true retention; CESR) and incomplete (incomplete CES; CESI). In incomplete type, patient refers with motor and sensory problems including saddle like numbness without complete urinary retention or incontinence, but in complete type, patient has complete retention with asymptomatic and painless urinary retention, without Visceral signals and is usually suffered by overflow incontinence (12). To study Cauda equina syndrome, in addition to the clinical history and examination, imaging, electromyography and urodynamic study are used. However, studies have shown that examination of imaging and EMG-NCV is useful in the diagnosis of the disease, they also have shown that urodynamic study is offensive and usually not needed for CES diagnosis, but it may be useful in follow-up of bladder function after treatment (12, 13).

Of therapies for the disease, we can mention to decompression surgery. Of course, it is controversial to choose the best time to do the surgery but most authors suggest that decompression should be done as soon as possible, and 24 hours after symptom onset is the probable most appropriate time. It is also controversial on whether the time of surgery is effective on motor function, sensory and improvement in urinary disorder created. However, there is no exact information about the role and effectiveness of clinical information in F/U period (14-16). Therefore, due to the high morbidity of Cauda equina syndrome and lack of sufficient information about the connection between the disease and urodynamic findings and EMG (Electromyography) findings, the need for this comprehensive study is felt. It is so important to diagnose the syndrome due to sphincter disorders and pain and numbness in the patient. In general, the study of this syndrome is rarely done. So the study was conducted in order to examine more comprehensively and study the predictive effect of electromyography findings and urodynamic studies in patients with this syndrome.

## 2. PATIENTS AND METHODS

This study is observational. Data was collection by examination and interview with questionnaire for patients with Cauda equina syndrome referred to neurosurgery clinic of Shohadaye Tajrish Hospital, Tehran, Iran. Because of the rarity of the disease and limited total number of patients in the 4-year period (from 2009 to 2013), 15 patients were enrolled in the study. Entry criteria of this study included patients with HX of LBP or Radicular pain, saddle sense disorders, acute urinary retention as sphincteric symptoms, motor weakness in the lower extremities and MRI imaging studies with data matching with lumbar disc herniation. The severity of the lesion and dysfunction was determined using impairment scale (AIS) and Barthel Index (BI), respectively.

For patients studied, complete demographic information was recorded such as age, sex, length of the disease course, underlying diseases, possible history of trauma and drug use. After the initial measurements, patients underwent emergency decompression of spinal canal. Then, they also underwent urodynamic examination and perineal electromyography (EMG-NCS) in 3 times, the day immediately after surgery (basic check), after a month (as the first F/U) and after 6

months (as the second F/U).

Data obtained were studied by the software SPSS Ver. 20 using Pearson correlation test to evaluate the relationship between detrusor function and the level of injury.

## 3. RESULTS

Total amount of 15 patients with Cauda equina improved by MRI imaging studies were entered in this study (Figure 1). Of these, 10 patients underwent surgery in the first 48 hours and 5 patients experienced delayed surgery. Results showed motor deficits that half of the patients, who underwent surgery within 48 hours, didn't have motor deficits in the first F/U and the rest of them were cured in the second F/U. However, 33% of patients with delayed surgery were cured after the first and the second F/U. Among 10 patients (66.7%) with acute sensory disorder in the initial clinical examination, 5 patients underwent surgery in the first 48 hours and 5 patients after that. Results showed that 60% of patients underwent early surgery during F/U were improved in sensory function and only one patient still suffered from sensory impairment after 6 months.

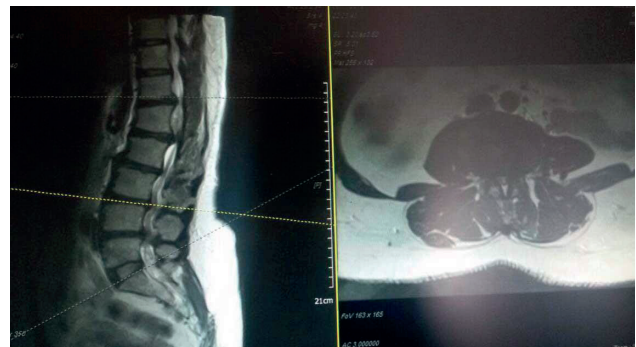


Figure 1. The MRI results of a patient suffered from Cauda equina syndrome. T2 sagittal and axial of lumbosacral spine with obvious disk herniation or extrusion

It was while that only one patient improved in the delayed surgery group. Of 13 patients with anesthesia saddle, 9 patients underwent early surgery that 53.3% of them showed a degree of improvement. It was while that in 4 patients who underwent surgery after 48 hours, only one patient showed improvement after 6 months. All patients suffered from urinary retention that results in 10 patients with early surgery showed 50% improvement in 1-month follow-up. Of course, only 2 patients had the ability to completely and spontaneously urinate.

Motor NCS (ms)					Sensory NCS (ms)			
Side	Nerve	D Latency	NCV	F wave	Side	Nerve	D Latency	NCV
R	Tibial	5.8	37	0	R	SPN	2.7	
R	DPN	5.5	36	0	L	SPN	2.5	
L	Tibial	5.7	37	0	R	Sural	3.1	
L	DPN	5.6	38	0	L	Sural	3	
					R&L	Saphenous	2.4	

Electromyography (EMG)						
Side	Muscle	IA	Fib	Psw	Fase	Volitional Activity
L	Gastrocnemius Tibial S1, S2	↑	+	2+	-	Poly MUAP, decreased Interference
L	Vast Med Femoral L2-L4	↑	+	+	-	Poly MUAP, decreased Interference
L	Tibialis Ant DPN L4, L5	↑	+	3+	-	Poly MUAP, decreased Interference
L	Peroneus Longus SPN L5, S1	↑	+	2+	-	Poly MUAP, decreased Interference
R	Peroneus Longus SPN L5, S1	↑	-	2+	-	Poly MUAP, decreased Interference
R	Tibialis Ant DPN L4, L5	↑	+	+	-	Poly MUAP, decreased Interference
R	Vast Med Femoral L2-L4	↑	+	2+	-	Poly MUAP, decreased Interference
R	Gastrocnemius Tibial S1, S2	↑	+	+	-	Poly MUAP, decreased Interference
L & R	Rectus Femoralis Femoral L2-	↑	+	+	-	Poly MUAP, decreased Interference

Table 1. The EMV-NCS results of a patient with Cauda equina syndrome. These results showed Low amplitude CMAPs of bilateral DPNs and Tibial nn, abnormal H-Reflexes, and Abnormal F-Waves.

**EMG-NCS Results:** All patients underwent electromy-

ography in 3 stages, including immediately after surgery, one month after surgery and 6 months after surgery. One of the ENG-NCS results can be seen in Table 1 as a sample. The presence of PSW and Fibrillation waves in patients' electromyography was examined in the times studied. The results can be seen in Figure 2.

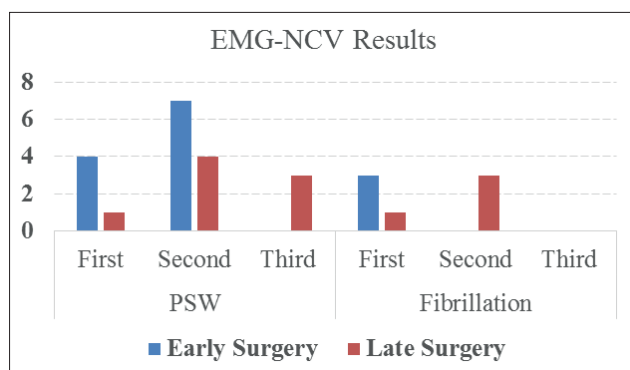


Figure 2. The results from the study of PSW and Fibrillation waves in patients' electromyography in both groups

According to the available data and statistical analysis, there was no significant relationship between the time of surgery and perineal electromyography findings in patients. The results also did not show an association between EMG-NCS and clinical examinations (sensory-motor disorder and deficit, sensory disorder in the saddle area). Given that PSW and Fibrillation waves were not observed almost in all patients' electromyography after follow-up period, it is shown that Denervation process stops after decompression surgery.

**Urodynamic Results:** In this study, three factors were studied including the maximum power of urine during urination (Qmax), Bladder Contractility index (BCI) and Post Voiding Residue (PVR). Figure 3 shows the average changes

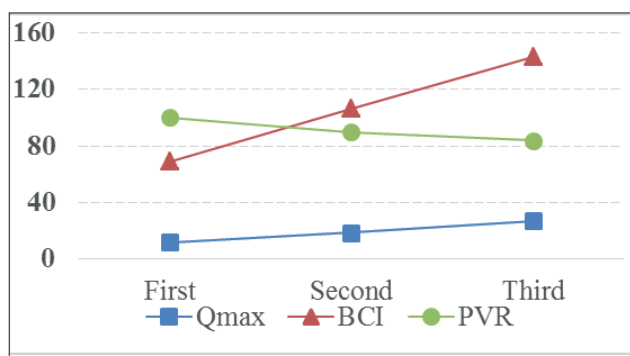


Figure 3. The average changes in Qmax, BCI and PVR factors in all patients, apart from the group of study, during the three times selected

		Early Surgery Group	Late Surgery Group	Average for all patients
Qmax (mm/sec)	First	13.6	7.6	11.6
	Second	21.7	11.8	18.4
	Third	31.5	18	27
BCI	First	80.4	47.7	69.3
	Second	123.6	73	106.7
	Third	166.4	98	143
PVR (ml)	First	75.5	151.4	100
	Second	65	141.6	90
	Third	56.2	140.6	84

Table 2. The results obtained from urodynamic study

in these factors in all patients, apart from the group of study, during the three times selected.

Average results from this study in patients in each group during the review period for each factors examined can be seen in Table 2.

Statistical analysis showed that there was a significant linear relationship between the time of surgery and BCI amount (P-value <0.05). Also, a similar significant but stronger relationship was observed between Qmax and time of surgery (P-value <0.005). Finally, a significant relationship was observed between the time of surgery and PVR (P-value <0.05).

#### 4. DISCUSSION

Cauda equina syndrome is a controversial disease in neurosurgery and the time of surgery and its impact on recovery is not yet consensus (1). In 2007, Sisson et al examined 17 patients with Cauda equina syndrome and suggested that this disease is one of the neurosurgery emergencies and the patient will recover in sensory, motor, and urinary disorders if they undergo decompression immediately. Also prior to this, 15 patients with CES clinical symptoms and 7 patients without symptoms underwent discography, epidurography and electromyography by this research group in a case-control study in 1992. Electromyography of paraspinal and pelvic muscles was performed in 13 patients. The results of study discogram and epidurogram showed that 6 of 7 patients are normal in the control group. Electromyographic analysis showed that 100% of samples with CES symptoms were diagnosed with this test. The study concluded that EMG is highly sensitive for the diagnosis of Cauda equina syndrome (17).

Similar to results obtained in this study, in a study conducted in 2008 by Sekiguchi et al in 2008, acute and chronic Cauda equina syndromes were compared using NCV in patient. Cyrtosole was used in this study. The study showed that the use of cilostazol in CES improves neurotransmission, as well as the blood flow and the improvement occurs in both acute and chronic groups. The study also showed that NCV findings are associated with improved overall health and improvement in NCV is accompanied by CES improvement symptoms, as well as improvement in disability resulted from CES (18).

Gupta et al in 2013, after urodynamic study in patients with neurogenic bladder after myelopathy concluded that there was no relationship between detrusor overactivity as a clinical symptom and urodynamic findings. In this study, Cauda equina syndrome did not examined as one of the causes of neurogenic bladder, however, in their study, PVR increased among all patients, similar to patients with Cauda equina syndrome (19).

In the study of Pondar et al in 2006, bladder dysfunction in patients with this syndrome was examined. 88% of patients studied in this study suffered from varying degrees of bladder dysfunction. EMG study showed that external anal and sacral reflex was abnormal in 88% and 84%, respectively. Linear regression showed that the loss of perineal sense and female sex have a positive impact on patients' urinary incontinence. The study concluded that due to poor communication between urodynamic study findings and the symptoms, it does not have induction in the diagnosis of disease (20). In a study by Lazaaro et al in 2004, effects and changes of electromy-

ography in patients with lumbosacral lesions were studied. The group stated that the findings of EMG-NCV acute phase has no statistical correlation with patient's clinical symptoms and suggested that clinical findings are more reliable than EMG-NCV findings for the diagnosis and the findings have a higher prognostic value that it was consistent with the results obtained in this study (21). The results of the study in EMG acute phase showed no relationship with clinical findings and urodynamic study in patients. Since a period of time is required from the start of nerve damage until the diagnosis of damage in electromyography, this finding is justified.

However, in the chronic phase and after surgery, the evidence of acute denervation such as PSW and Fibrillation disappears in patients, that the result was observed after 6 months in all patients. Therefore, the disappearance of PSW and Fibrillation on EMG suggests the stop of denervation acute phase, but it cannot reflect the severity of the damage in the acute phase and duration of damage during this phase (22).

The results showed that the level and amount of  $Q_{max}$  has a direct and linear relationship with the start time of symptoms until the time of surgery. Even, it was shown in patients with delayed surgery that the sooner patients are undergoing surgery, the more the average increase in  $Q_{max}$  will be during recovery. Due to the cases among findings obtained in this study,  $Q_{max}$  (especially  $Q_{max}$  after 6 months) is one of the strongest predictors of recovery in urination power and clinical improvement after decompression. The results also showed a linear relationship between the urination power and BCI level after surgery, that the relationship had the strongest relationship with the time of surgery among urodynamic inductions. On the other hand, PVR had a significant relationship with the time to surgery. It should be noted that PVR reduction gradient was slight and longer studied are needed for its full recovery.

## 5. CONCLUSION

According to the results of this study it is suggested that surgeons employ EMG findings as adjuvant information in combination with the examination and imaging and findings during surgery. On the other hand, quantitative findings on urodynamic study including evaluation of  $Q_{max}$ , BCI and PVR is clearly consistent with the recovery level of patient's urination power and can be used as a prognostic factor in these patients and represents an improvement.

- Author's contribution: Mohammadreza Shahmohammadi and Reza Jalil Khoshnod made substantial contribution to conception, design, drafting the article and critical revision for important intellectual content. Alireza Zali and Amir Saied Seddighi made substantial contribution to acquisition of data, analysis and interpretation of data and critical revision for important intellectual content. Nima Mohseni Kabir made substantial contribution to conception and design. All the authors approved the final version to be published.
- Conflict of interest: none declared.

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