

# Transcranial Magnetic Stimulation for Early Rehabilitation Using Improved Cylindrical Cages in Patients with Complicated Cervical Spine Hernia

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**Abstract** According to US population health statistics [1], most people under the age of 45 are limited in their activities due to persistent back and neck pain, and the prevalence of chronic spinal pain among the elderly population reaches 26-32%. Spinal pathology ranks 5th among the causes of hospitalization and 3rd among indications for surgical treatment [1]. Diseases of the peripheral nervous system account for more than 50% of the disability of the elderly population of Russia. High level of disability: disability occurs in 80% of cases due to secondary damage to the peripheral nervous system on the background of spinal diseases [2]. In addition, neck and back pain restrict vital activity, reduce the quality of life, change the psyche and behavior. More than half of patients with osteochondrosis of the spine have symptoms of chronic emotional stress [2]. One of the modern and promising neurotherapeutic methods is high-intensity magnetic stimulation in the early period after the removal of herniated discs. The magnetic field has no thermal effect, is easier to tolerate by patients than electromagnetic exposure, and has fewer contraindications. The magnetic field causes positive (positive) changes in the physiological and biological processes of the nervous system [3]. When treated with a magnetic field, the sensitivity of the receptors of the peripheral nervous system decreases, which leads to a decrease in pain and an improvement in conductivity; axon growth, improving axon myelination and inhibiting the development of connective tissue in them, promotes the regeneration of damaged peripheral nerve endings [4,5].

**Keywords** TMS stimulation

## 1. Introduction

So, in 2014, S.C. Barros Galvão and others investigated the effectiveness of randomized double low-frequency placebo-controlled stimulation of the M1 cortex (1 Hz) of the intact cerebral hemisphere in relieving post-stroke spasticity. After 10 sessions of stimulation and a course of physical therapy, 90% of patients immediately and 55.5% at the next 4-week study showed a decrease in spasticity by 1 point or higher on the Ashford scale [4].

**The aim of** our study is to improve the results of patients with complicated herniated discs of the cervical region using advanced cylindrical cages and transcranial magnetic stimulation in the early period after the removal of herniated discs.

## 2. Material and Methods

The study was based on the analysis of 103 patients (70 (67.8%) men, 33(32.2%) women aged 24-83 years, average age –  $55.1 \pm 0.68$  years) with hernias of the cervical spine. All patients underwent surgery for cervical spine discectomy in the period 2018-2023 at the National Center for Rehabilitation and Prosthetics of Persons with Disabilities. The patients are divided into two groups. The first (main) group of 46 (44.6%) patients underwent "discectomy with decompression of the spinal cord, followed by stabilization with an improved cylindrical cage of the clinic and of these 15 (14.5%) patients using TMS stimulation in the early/long-term postoperative period." The second group of patients underwent discectomy, using cylindrical cages, corporectomy, stabilization with MESH and plates, and of these 17 (16.5%) patients received TMS stimulation.

In the middle part of the cervical spine, in the VC 5-6 and VC6-7 segments, disc herniation is the most common. All patients underwent neurological examination, neuro-visual examination, EMS (European Myelopathic Scale) assessment, ENMG, functional radiography, Dopplerography as needed, as well as examinations by neurologists and related specialists before and after treatment. Clinical signs before the start of treatment. (before the operation,  $P < 0.001$ ,  $R_i = 0.8$ ).

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**Table 1**

	Neurological symptoms	Number of patients
1	Segmental disorders	32/103
2	Neck pain	72/103
3	Traffic violations	32/103
4	Limitation of movements in the neck area	39/103
5	Upper paraparesis	11/103
6	Light and medium tetraparesis	21/103

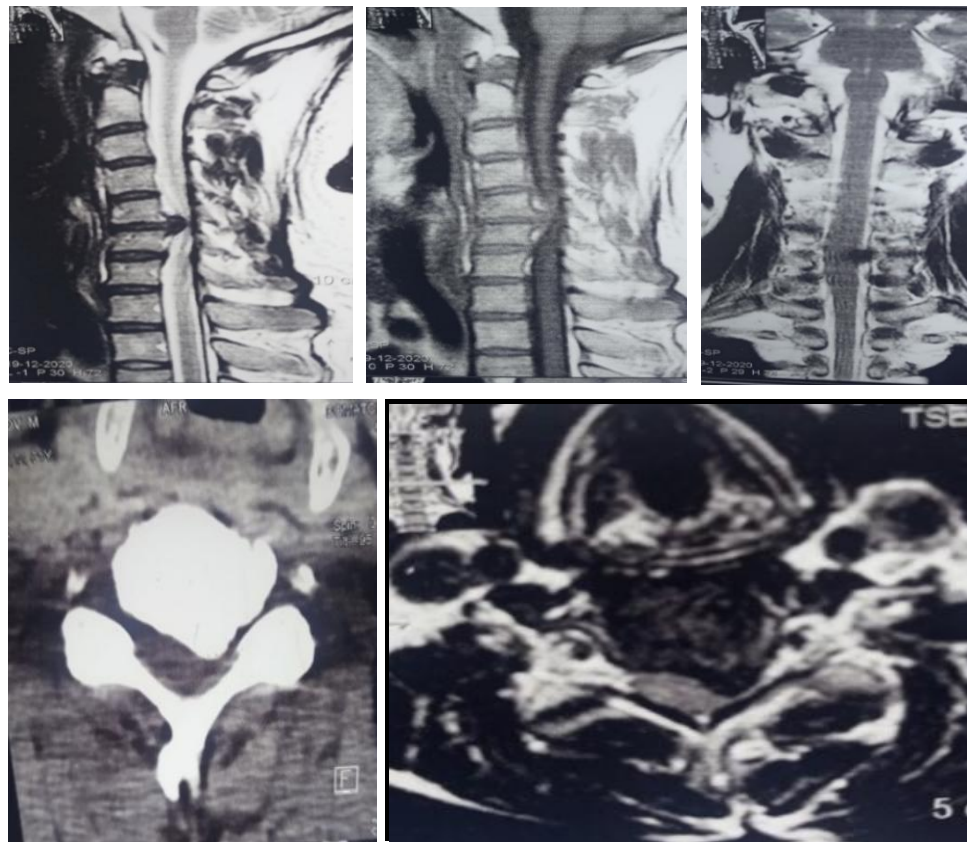
Pain in the cervical spine from irradiation to the upper extremities was the main complaint in 69.9% of cases. In many cases, the pain syndrome intensified and later acquired a radicular character. In some cases, against the background of pain, there were signs of direct damage to the spinal cord with the development of signs of conduction-type disorders.

### 3. Results and Discussion

The results of open surgical interventions were evaluated in two groups, according to the performed surgical intervention and the use of TMS. The first (main) group of 46 (44.6%) patients underwent "discectomy with decompression of the

spinal cord, followed by stabilization with an improved cylindrical cage of the clinic and of these 15 (14.5%) patients using transcranial magnetic stimulation in the early/long-term postoperative period." The second group of patients underwent discectomy using cylindrical cages, corporectomy, stabilization with mesh and plates, stabilization with telescopic mesh, and of these 17 (16.5%) patients received TMS stimulation. Patients of the first group underwent left-sided anterior parapharyngeal surgery under the control of EOP under general intubating anesthesia.

A clinical example. Patient R.S., 49 years old. Medical history No. 1784/1332. Hospitalized on 06/22/2018. I've been worried about it for 2 years now. Complaints: pain in the left arm, pain when moving the neck, dizziness, numbness of the fingers of the left hand, tingling (Lermitt's symptom is positive), slight weakness in the legs and arms. 13-14 points on the EMS scale. ENMG conclusion: Edema along the left radicular segment of the neck C6, signs of radiculomyelopathy with a compression-irradiation component. The final diagnosis: "Osteochondrosis of the cervical vertebrae. Herniated intervertebral disc L5-6. Secondary stenosis VC 5-6 of the spinal canal. Compression myelomalacia VC5-6. Mild tetraparesis. Partial violation of CHUBB."



**Figure 1.** Surgery was performed on 06/22/2018: "Anterior parapharyngeal access, VC5-C6 body resection, adequate spinal cord decompression, spinal fusion with an improved clinic cage and screw." Intraoperative EOP, postoperative radiography



Figure 2

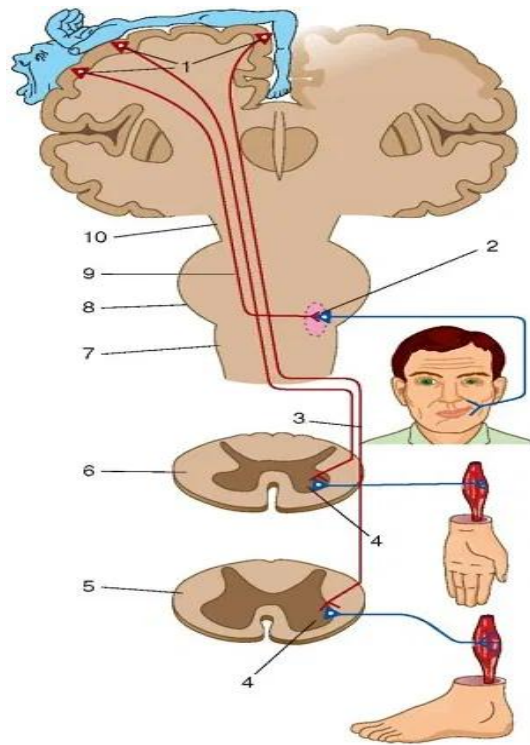
Complicated forms of herniated discs of the cervical spine after adequate decompression of the spinal cord with anterior parapharyngeal access from the left, discectomy and complete removal of osteophytes, ossified bones and stable spinal fusion using an improved cylindrical cage developed by the clinic, with the use of TMS in the early period for rehabilitation showed positive results. Low- and medium-

frequency magnetic stimulation of 2-5 Hz motor centers of the cerebral cortex was performed in 15 patients with spastic tetraparesis with increased limb reflexes to eliminate neurological complications and spastic contractions. Magnetic stimulation was applied to patients in the early period after surgery, that is, from day 1 for 3-5 days, 1 or 2 sessions per day (depending on the instructions) for 15-20 minutes.



**Figure 3.** Equipment overview and transcranial magnetic stimulation procedure. Transcranial magnetic stimulator (Neuro-MS/D) 1 – main unit; 2 – cooling module; 3 – charging module; 4 – inductor bracket; 5 – display and programs





**Figure 4.** Diagram of the cortico-muscular pathway: 1 - central (upper motor neurons) neurons; 2 - source of the facial nerve (peripheral motor neuron of the heart muscle); 3 – corticospinal tract (pyramidal system); 4 - peripheral lower motor neurons (anterior branches of the spinal cord - motor neurons); 5 – narrowed lumbar segment; 6 - narrowed cervical segment; 7 – medulla oblongata; 8 - brain bridge; 9 - corticonuclear pathway; 10 - brain stem

TMS Report (Протокол)		
NO : 2018 04 25 709051487		
Patient information		
Name <b>Ғаниев Ўразбай</b>	Age <b>1941</b>	Phone
Active Motor Threshold (AMT):100	Resting Motor Threshold (RMT):100	Peripheral Motor Threshold (PMT):100
Address		
Chief Complaint		
Diagnosis <b>VC 5-6 disk churrasi olish J AKX (24.04.2018)</b> <b>Asorati/ Tetroparez urta darajasi CHAFB</b>		
Treatment information		
Hospitalization No.:	Report time <b>2018 04 25</b>	
Stimulation protocol: <b>DEFAULT</b>	Stimulation position:	
Date of <b>2018 04 25</b> 11:15	Stimulation result: <b>unfinished</b>	
Remaining stimulation time (s)1041	Remaining stimulation <b>3000</b>	
Time of the stimulation (s4)	Pulses of the <b>20</b>	
Protocol detail		
MT:100(RMT) мощность аппарат	Intensity (ампл): <b>30</b>	Frequency: <b>10 Гц</b>
Ntim:10	Duration_time(ms): <b>100</b>	Nsequences (бир стимуляциядаги зарбалар сони): <b>20</b>
ISI(s) (1 стимуляцияга кетадиган вақт): <b>2</b>	ПИ(с интервал): <b>5</b>	Ntrains (стимуляция сони): <b>150</b>
Total time (жами минут): <b>22</b>	Total_pulses (жами импульс сони): <b>3000</b>	
Signature: _____ Date: 25.04.2018		
Signature: _____ Date: 26.04.2018		
Signature: _____ Date: 27.04.2018		
Signature: _____ Date: 28.04.2018		
Signature: _____ Date: 29.04.2018		
Signature: _____ Date: 30.04.2018		
Signature: _____ Date: 01.05.2018		
Signature: _____ Date: 02.05.2018		

TMS Report (Протокол)		
NO : 2018 07 20 999051267		
Patient information		
Name <b>Ғаниев Ўразбай</b>	Age <b>1941</b>	Phone
Active Motor Threshold (AMT):100	Resting Motor Threshold (RMT):100	Peripheral Motor Threshold (PMT):100
Address		
Chief Complaint		
Diagnosis <b>VC 5-6 disk churrasi olish J AKX (24.04.2018)</b> <b>Asorati/ Tetroparez urta darajasi CHAFB</b>		
Treatment information		
Hospitalization No.:	Report time <b>2018 07 20</b>	
Stimulation protocol: <b>DEFAULT</b>	Stimulation position:	
Date of <b>2018 07 20</b> 11:15	Stimulation result: <b>unfinished</b>	
Remaining stimulation time (s)1041	Remaining stimulation <b>3000</b>	
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Protocol detail		
MT:100(RMT) мощность аппарат	Intensity (ампл): <b>30</b>	Frequency: <b>10 Гц</b>
Ntim:10	Duration_time(ms): <b>100</b>	Nsequences (бир стимуляциядаги зарбалар сони): <b>20</b>
ISI(s) (1 стимуляцияга кетадиган вақт): <b>2</b>	ПИ(с интервал): <b>5</b>	Ntrains (стимуляция сони): <b>150</b>
Total time (жами минут): <b>22</b>	Total_pulses (жами импульс сони): <b>3000</b>	
Signature: _____ Date: 20.07.2018		
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Signature: _____ Date: 24.07.2018		
Signature: _____ Date: 25.07.2018		
Signature: _____ Date: 26.07.2018		
Signature: _____ Date: 27.07.2018		

**Figure 5**

Patient G is 83 years old. a) Protocol of rhythmic TMS 1-8 days after surgery, on ENMG: bilateral edema of the C5 and C6 root is noted, with compression-irradiation components of radiculomyelopathy. Neurological impairment on the EMS scale of 11 points, grade II (moderate). b) 3 months after surgery, on ENMG: bilateral C5 and C6 root of the compression-irradiation component with radiculomyelopathy. Neurological disorder on the EMS scale of 16 points, grade I (mild). The results of treatment after receiving TMS in the main group of patients in the early period after surgery with the best indicators. The table shows the results of TMS. All patients had a decrease in preoperative spasticity of up to 50% after 6-10 sessions. All patients underwent TMS therapy 3-6 months and 1-2 years after surgery for early rehabilitation. To this end, repeated course sessions were conducted, and in the early and long-term follow-up period, a decrease in spastic contractions and positive neurological changes were noted. (Table 4). In tables 2 and 3 the dynamics of neurological changes after surgery in patients with herniated discs is presented. Table 4 shows the pain index on the VAS scale before and after the procedure. Clinical signs of patients after hospital treatment ( $P<0.001$ ,  $R_i=0.8$ ).

Table 2

	Neurological symptoms	1- group	2- group
1	Segmental disorders	15/46	17/57
2	Neck pain	32/46	40/57
3	Conduction disturbances	15/46	17/57
4	Limitation of movements in the neck area	18/46	21/57
5	Upper paraparesis	5/46	6/57
6	Light tetraparesis	10/46	11/57

Table 3. Clinical signs after 3-6 months. ( $P<0.001$ ,  $\chi^2=0.013$ )

	Neurological symptoms	1- group	2- group
1	Segmental disorders	8/46	12/57
2	Neck pain	3/46	9/57
3	Conduction disturbances	8/46	12/57
4	Limitation of movements in the neck area	2/46	4/57
5	Upper paraparesis	3/46	4/57
6	Light tetraparesis	5/46	8/57

Table 4. Indicators on the VAS scale before and after surgery

	VAS	1- group	2- group	$P = \chi^2$
1	VAS before the operation	8,6+1,9	8,2+1,6	$P<0,001$ , $Kcu=0,94$
2	VAS after discharge	2,9+1,6	5,9+1,4	$P<0,001$ , $Kcu=0,077$
3	VAS 3-6 months after surgery	1,9+1,2	4,2+1,3	$P<0,001$ , $Kcu=0,077$
4	VAS 1-2 years after surgery	1,3+1,4	4,1+1,3	$P<0,001$ , $Kcu=0,077$

During orthopedic and neurological examinations, all metric indicators turned out to be better than during preoperative examination. Allergic reactions, inflammation, implant migration

and instability were not observed in patients of the main group in the early and long-term period. According to the standard examination, in the long-term period, 14 (30.4%) out of 15 (32.6%) patients with complications of the main group had no neurological complications on the EMS scale of 17-18 points or the "norm" criterion, and in 1 (2.2%) patient from 9-12 (average) points were restored to 13-16 points (light degree). 12 (21%) of 17 (29.8%) patients with complications of the control group had no neurological complications on the EMS scale of 17-18 points or the "norm" criterion, and 5 (8.8%) patients with 9-12 points (moderate degree) were restored to 13-16 points (mild degree). Our study did not select patients with severe profound neurological disorder, that is, with a clinical picture of 5-8 points on the EMS scale of cervical myelopathy. Statistical analysis shows that (before surgery,  $P<0.001$ ,  $\chi^2=0.8$ ) with herniated discs of the cervical spine - by adequate decompression of the spinal cord, with anterior access, the use of an improved titanium cage clinic, and for rehabilitation purposes, the use of early and long-term rhythmic TMS had a positive effect (indicator of the long-term period  $P<0.001$ ,  $\chi^2=0.167$ ).

## 4. Conclusions

1. After adequate decompression of the spinal cord by parapharyngeal access in hernias of the cervical spine, it is advisable to use an improved cylindrical cage of the clinic in order to stable stabilization of one or more segments.
2. The use of transcranial magnetic stimulation in the early postoperative and long-term periods for herniated discs of the cervical spine makes it possible to awaken and restore long-lost neurological deficits, lost muscle groups and, in some cases, entire organizations early.
3. The use of the clinic's advanced cylindrical cage for herniated discs of the cervical spine does not require the use of additional plates in cases of displacement and instability of the vertebrae, as well as in osteoporosis of the vertebrae, which increases economic efficiency for the patient and the hospital.

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