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Short-term surgical outcomes in patients with sciatic nerve injury associated with total hip arthroplasty

V.S. Tolkachev[1]✉, S.P. Bazhanov[1], G.A. Korshunova[1], S.V. Kapralov[1], V.Yu. Ulyanov[1,2], V.V. Ostrovskij[1]

[1] V.I. Razumovsky Saratov State Medical University, Saratov, Russian Federation
[2] Reaviz Medical University, Saratov, Russian Federation

Corresponding author: Vladimir S. Tolkachev, vladimir.tolkache@yandex.ru

Abstract

Sciatic nerve (SN) injury associated with total hip arthroplasty (THA) is a challenging issue due to the high prevalence of the complications. However, there is no consensus about the injury mechanism, surgical treatments, indications and timing for the surgeries which necessitates the studies. The objective was To perform a comparative analysis of the dynamics in clinical, neurological and electrophysiological parameters in patients with sciatic nerve injuries associated with THA performing various surgical treatments. **Material and methods** The study included 61 patients who were hospitalized between 2005 and 2021. Patients were divided into two groups being homogeneous in terms of gender, age and severity of neurological deficit. Microsurgical neurolysis of the sciatic nerve trunk was performed in group I (n = 32) and was added by direct electrical stimulation of the sciatic nerve at the level of injury in group II (n = 29). Clinical, neurological status and electroneuromyography parameters of the patients were assessed preoperatively and at 6 months of surgery. **Results** All patients showed pain relief with VAS score decreasing from 6 (5.5; 8) to 4 (2; 6) in group I and to 3 (1; 5) in group II ($p < 0.001$). Functionality of the lower limb scored preoperatively 31 (24.5; 40.5) on the ODI scale in group I and 27 (21; 36) in group II. The patients showed positive dynamics postoperatively with improved lower limb function due to decreased neuropathic pain syndrome scoring 28 (20; 34.5) in group I and 16.5 (8.5; 21.75) in group II ($p < 0.0001$). **Conclusions** The findings suggested the advantages of the electrical stimulation method in combination with microsurgical neurolysis of the sciatic nerve over the use of microsurgical neurolysis alone with decreased intensity of the pain syndrome and functional insufficiency of the lower limb.

Keywords: total hip arthroplasty, neuropathy, sciatic nerve

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INTRODUCTION

Sciatic nerve injuries (SNI) can occur in total hip arthroplasty (THA) accounting for 0.16-8 % of all complications with the procedure [1-3]. In 2005, C.M. Farrell et al. reviewed outcomes of 27,004 THAs with SNI reported in 0.17 % of cases [4]. SNI can be caused by traction, mechanical trauma with a surgical retractor, postoperative hematoma [4, 5]. Risk factors for SNI include hip dysplasia, posterior access during THA, revision surgery, the need for intraoperative limb lengthening, female gender and young age of patients [6-8].

A high level of nerve injury is observed with THA associated SNI and the onset of severe neurological deficiency and rapidly developing complex regional pain syndrome (CRPS) in the lower limbs [9]. With common surgical treatments of SNI including microsurgical neurolysis (MN) and neurotization complete recovery of the useful lower limb function after SNI is rare despite the use of microsurgical methods of reconstruction. Progressive muscle atrophy developing with prolonged limb denervation is the reason for the condition [10-12]. The use of standard surgical techniques and electrical stimulation (ES), including direct stimulation of the peripheral nerve and segmental apparatus of the spinal cord and their combined use is a promising method of treatment. They are practical for patients with CRPS with the action aimed at reducing the severity of the pain syndrome [11].

However, there is controversy regarding indications and timing of the use of ES. There is a paucity of studies evaluating the regeneration of the neuromuscular apparatus with the use of ES, and most of the studies were performed on animal models [13]. The timing and indications for the use of ES in inpatients are current determined empirically and according to the personal preferences of the attending physician [14]. The lack of unified recommendations on the use of various SNI treatments determines the relevance of studies aimed at comparing them and identifying the most effective modality in each specific case.

The **aim** of the study was to conduct a comparative analysis of the dynamics in clinical, neurological and electrophysiological parameters in patients treated for SNI with various surgical methods.

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MATERIAL AND METHODS

This is a monocentric, longitudinal, open, retro- and prospective study conducted in compliance with the Geneva Convention and approved by the local ethics committee of the Saratov State Medical University named after V.I.Razumovsky, the Ministry of Health of Russia (minutes of the meeting of the ethics committee of the SSMU named after V.I. Razumovsky of the Ministry of Health of Russia No. 7 of 02.02.2021).

The inclusion criteria were patients age from 18 to 65 years for males and 18 to 60 years for females, an isolated SNI, an injury of Sunderland grades II-IV, previous conservative treatment performed according to the standards of medical care within a period of at least 3 months from the date of injury, signed voluntary informed consent of the patient to participate in the study. The study included 61 patients with SNI who were hospitalized in the neurosurgical department of the Research Institute of Nuclear Medicine, SSMU between 2005 and 2021. The study was conducted in two groups being homogeneous in gender, age and severity of neurological deficiency. Group I included 32 patients (retrospective study) and group II consisted of 29 patients (prospective study).

MN of SN was performed for patients of group I under spinal anesthesia with the patient lying on the stomach. SN was isolated using an approach along the posterior midline of the femur. The skin, subcutaneous tissue, fascia of the femur were dissected. The long head of the biceps was retracted medially in the upper third of the femur and the gluteus maximus muscle was partially incised. The fascial sheath was dissected with the muscles disengaged and SN identified and MN performed.

Patients of group II underwent post-MN implantation of eight-channel electrodes on the SN trunk at the level of the subpiriform foramen. The electrodes were removed from the wound through the counter-opening and fixed to the skin with interrupted sutures. The wound was sutured in layers. Stimulation parameters were selected individually using the minimum parameters with the evoked response of the lower limb muscles recorded with electroneuromyography (ENMG). Stimulation sessions were performed 3 times a day for 10-15 minutes for 14 days. The patients underwent conservative treatments postoperatively including complex physiotherapy and medications. Clinical, neurological and electrophysiological parameters were assessed at 6 months. A visual analog scale (VAS), the Oswestry Disability Index (ODI), five-point scales of muscle strength and sensitivity were used. Characteristics of the M-response: amplitude, latency, impulse conduction velocity (ICV) were used to compare ENMG parameters. Statistical analysis was performed using Microsoft Office Excel 2019, IBM SPSS Statistics v23. Data were evaluated using descriptive and nonparametric statistical methods. The Mann-Whitney U test and the Wilcoxon test were used. The Mann-Whitney U-test was used to assess the significance of the differences. Differences between groups were considered statistically significant at $p < 0.05$.

RESULTS

The patients had high CRPS preoperatively with no differences between the groups ($p = 0.953$); the Me (Q1; Q3) according to the VAS scored 6 (5.5; 8). The patients showed a decrease in the intensity of the pain postoperatively with no complete regression observed in a case. The VAS median values and interquartile interval scored 4 (2; 6) in group I and 3 (1; 5) in group II ($p < 0.001$) (Fig. 1).

Moderate and high deficiency of the lower limb functionally measured preoperatively with the ODI scale was seen in the majority of patients. The mean ODI score was 31 (24.5; 40.5) for group I and 27 (21; 36) ($p = 0.476$) for group II. The patients showed positive postoperative dynamics in the lower limb functionality. Many patients reported the restored ability to walk maintaining weight-bearing on the affected limb due to the reduction of neuropathic pain syndrome with the decrease in functional insufficiency of the lower limb being less pronounced in group I. Postoperative ODI scores were 28 (20; 34.5) in group I and 16.5 (8.5; 21.75) points ($p < 0.0001$) in group II. period, in, Injury to both portions of the nerve was common for patients with SNI according to preoperative ENMG data while an isolated lesion of the tibial portion was quite rare and was noted in two cases only. Preoperative M-response of the SN branches are presented in the table.

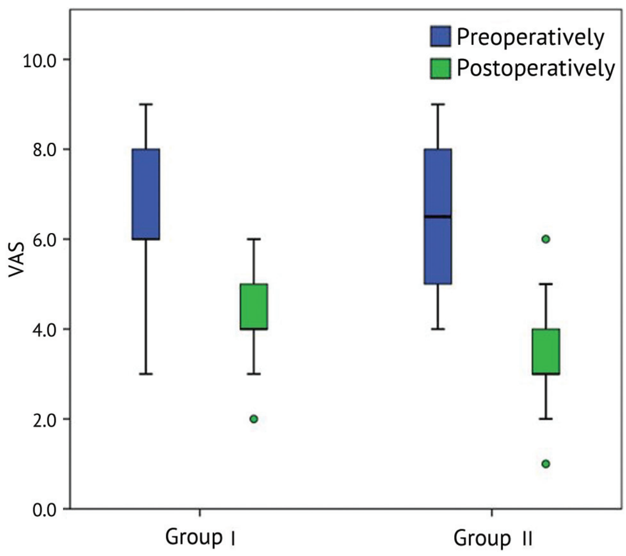

Fig. 1 Dynamics in pain in the groups I and II

Table

Preoperative M-response of the SN branches in the lower limbs, Me (Q1; Q3)

Stimulation point	M-response, mV	Latency, ms	ICV, m/s
Peroneal nerve			
M1	1.22 (0.1; 2.0)	3.70 (3.13; 5.075)	42.2 (38.5; 44.5)
M2	1.6 (0.9; 2.20)	15.0 (13.3; 16.3)	
Tibial nerve			
M1	1.9 (1.2; 3.67)	4.77 (4.0; 5.657)	43.4 (40.29; 46.6)
M2	2.6 (1.8; 3.6)	13.5 (11.23; 14.7)	

Note: M1, ankle joint; M2, knee joint

The data presented in the table indicate the prevalence of severe axonal SN lesions that were characterized by decreased amplitudes of the M-response and increased latency, decreased speed of impulse conduction along the nerves. Postoperatively, the patients showed increased amplitudes and a decrease in the latency of the M-response in the peroneal and tibial nerves according to stimulation ENMG. The median amplitude of the M-response of the peroneal nerve were 1.2 (0.275; 2.90) for group I and 1.6 (1.164; 2.23) $p = 0.257$ for group II. The latent period of the peroneal nerve was 3.7 (3.125; 5.15) in group I and 3.35 (3.00; 5.125), $p = 0.176$ in group II. For the tibial nerve, the amplitude of the M-response was 3.2 (1.3; 5.2) in group I and 2.16 (1.393; 2.6), $p = 0.217$ in group II, while the latent period was 4.6 (3.75; 5.5) in group I and 4.6 (3.96; 5.61), $p = 0.394$ in group II. Low-amplitude M-responses were recorded in stimulation points where the M-response had not been previously recorded in cases of severe and extremely severe damage to SN. The patients showed positive dynamics in electrophysiological parameters correlated with clinical data and were better expressed in patients with mild injuries. Positive dynamics in M-responses was significantly better in group II ($p < 0.05$) (Fig. 2).

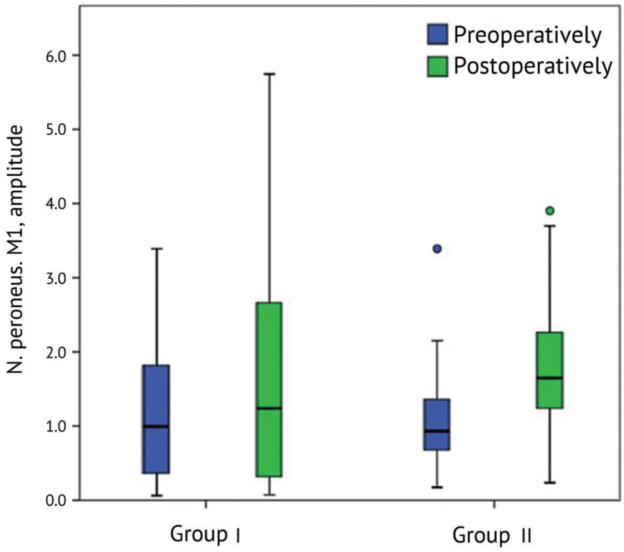

Fig. 2 Dynamics in M-responses at the ankle joint

Based on the analysis of clinical, neurological and electrophysiological parameters, the MN method in combination with ES showed higher efficiency compared to MN alone that was manifested by a more intense regression of pain syndrome and functional insufficiency of the lower limb and more pronounced dynamics in M-responses of involved nerves.

DISCUSSION

A pronounced decrease in pain syndrome was reported [15-17] with use of ES in patients with peripheral nerve damage with no ENMG findings of the peripheral sensorimotor apparatus reported in contrast to our series. There are reports of improved SN regeneration with use of ES. Meshcheryagina I.A. et al. [10] reported a successful case of SN neuropathy treated with THA. The electrode was placed on the SN stem with puncture method with chronic ES that determined the differences with our series. Based on the analysis of various surgical treatments in patients with SNI, a significant efficacy of MN in combination with a single-level ES (group II) was demonstrated compared with the use of MN alone (group I), and EMNG showed faster recovery at the proximal stimulation points. Persistent pain was noted postoperatively in patients of group I and prevented comprehensive rehabilitation and recovery.

Although functional neurosurgery is significantly developing with new treatment methods emerging, indications for the use expanding, new ES devices being introduced into practice [18] there is not enough scientific and clinical data collected to indicate an evident advantage of ES over other methods of complex treatment and indications for the use in various clinical scenarios. These facts necessitate further research and search for an optimal algorithm to select an adequate method of treating THA patients with SNI.

CONCLUSION

Although the MN is the most common treatment of SNI, the method of direct ES of SN in combination with MN can be a promising management as evidenced by the high rate of pain regression and improved functionality of the lower limb.

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Information about the authors:

1. Vladimir S. Tolkachev – vladimir.tolkache@yandex.ru, https://orcid.org/0000-0001-6580-4403;
2. Sergey P. Bazhanov – Doctor of Medical Sciences, baj.s@mail.ru https://orcid.org/0000-0001-9474-9095;
3. Galina A. Korshunova – Candidate of Medical Sciences, galina_kors@list.ru, https://orcid.org/0000-0003-3648-0141;
4. Sergey V. Kapralov – Doctor of Medical Sciences, sergejkapralov@yandex.ru, https://orcid.org/0000-0001-5859-7928;
5. Vladimir Yu. Ulyanov – Doctor of Medical Sciences, Associate Professor, v.u.ulyanov@gmail.com, https://orcid.org/0000-0002-9466-8348;
6. Vladimir V. Ostrovskij – Doctor of Medical Sciences, sarniito@yandex.ru, https://orcid.org/0000-0002-8602-2715.

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