Long-Term Outcomes of Management of Inferior Alveolar Neuropathy Following Orthognatic Surgeries in Patients with Mandibular Anomalies and Deformities

Marine M. Tanashyan[1], Marina Yu. Maksimova[1,2], Pavel A. Fedin[1], Tatiana Yu. Noskova[1]

[1]*Research Center of Neurology, Moscow, Russia;*
[2]*A.I. Evdokimov Moscow State University of Medicine and Dentistry, Ministry of Health of Russia, Moscow, Russia*

Abstract

Introduction. *Orthognatic surgery is a routine method to manage mandibular anomalies and deformities.*
Objective: *To assess long-term outcomes of rhythmic peripheral magnetic stimulation (rPMS) in patients with neuropathy of the inferior alveolar nerve (IAN) resulting from the surgical treatment of mandibular anomalies and deformities.*
Materials and methods. *The study included 8 males and 16 females aged 32 ± 12 years with IAN neuropathy following the surgical treatment of mandibular anomalies and deformities. Therapeutic rPMS was performed with the Neuro-MS magnetic stimulator (Neurosoft, Ivanovo, Ivanovo Region, Russian Federation). Trigeminal and brainstem acoustic evoked potentials (EPs) were registered with Neuro-MVP (Neurosoft) to assess rPMS both at baseline (in 10 days) and in long term (in 18 ± 2 months).*
Results. *Sensory disorders and pain prevailed in postoperative IAN neuropathy. Sensory disorders improved in 20 patients following 10-day rPMS. The clinical effect persisted in re-assessment. In long term, acoustic brainstem EPs normalized and trigeminal EPs did not change negatively.*
Conclusion. *The use of rPMS in IAN neuropathy following orthognatic surgeries contributes to the functional improvement and stabilization of the peripheral and central brainstem and the trigeminal system.*

Keywords: *IAN neuropathy; brainstem auditory evoked potentials; trigeminal evoked potentials; orthognatic surgery*

Ethics approval. The study was conducted after receiving the informed consent of the patients. The study protocol was approved by the Ethics Committee of the Research Center of Neurology (Protocol No. 11/4-19, 20 November 2019).

Source of funding. The study was conducted by the Research Center of Neurology on state assignment.

Conflict of interest. The authors declare no apparent or potential conflicts of interest related to the publication of this article.

For correspondence: 125367, Russia, Moscow, Volokolamskoye shosse, 80. Research Center of Neurology.
E-mail: ncnmaximova@mail.ru. Maksimova M.Yu.

For citation: Tanashyan M.M., Maksimova M.Yu., Fedin P.A., Noskova T.Yu. Long-term outcomes of management of inferior alveolar neuropathy following orthognatic surgeries in patients with mandibular anomalies and deformities. *Annals of Clinical and Experimental Neurology.* 2023;17(4):35–39.

DOI: https://doi.org/10.54101/ACEN.2023.4.4

Received 10.07.2023 / Accepted 07.09.2023 / Published 25.12.2023

Отдалённые результаты лечения нейропатии нижних луночковых нервов после ортогнатической коррекции аномалий и деформаций нижней челюсти

М.М. Танашян[1], М.Ю. Максимова[1,2], П.А. Федин[1], Т.Ю. Носкова[1]

[1]ФГБНУ «Научный центр неврологии» Москва, Россия;
[2]ФГБОУ ВО «Московский государственный медико-стоматологического университет им. А.И. Евдокимова» Минздрава России, Москва, Россия

Аннотация

Введение. *Ортогнатические операции являются наиболее распространённым методом лечения аномалий и деформаций лицевого черепа.*
Цель *исследования — оценка отдалённых результатов применения ритмической периферической магнитной стимуляции (рПМС) при нейропатии нижних луночковых нервов (НЛН), возникшей в результате хирургического лечения аномалий и деформаций нижней челюсти.*
Материалы и методы. *В исследование были включены 8 мужчин и 16 женщин в возрасте 32 ± 12 лет с нейропатией НЛН после ортогнатической коррекции аномалий и деформаций нижней челюсти. Для лечебной рПМС использовали магнитный стимулятор «Нейро-МС» («Нейрософт»). При оценке отдалённых результатов эффективности рПМС (через 18 ± 2 мес), как и при первом исследовании (через 10 дней), регистрировали акустические стволовые и тригеминальные вызванные потенциалы на приборе «Нейро-МВП» («Нейрософт»).*
Результаты. *В неврологической картине постоперационной нейропатии НЛН преобладали чувствительные и болевые нарушения. Клинический эффект в виде уменьшения чувствительных нарушений после 10-дневного курса рПМС наблюдался у 20 пациентов и сохранялся при повторном обследовании. В отдалённом периоде также отмечены нормализация параметров акустических стволовых вызванных потенциалов и отсутствие отрицательных изменений при исследовании тригеминальных вызванных потенциалов.*
Заключение. *Применение рПМС при нейропатии НЛН, возникшей после ортогнатических операций, способствует улучшению и стабилизации функции периферических и центральных структур ствола мозга и тригеминальной системы.*

Ключевые слова: *нейропатия нижних луночковых нервов; акустические стволовые вызванные потенциалы; тригеминальные вызванные потенциалы; ортогнатические операции*

Этическое утверждение. Исследование проводилось при добровольном информированном согласии пациентов. Протокол исследования одобрен Этическим комитетом Научного центра неврологии (протокол № 11/4-19 от 20.11.2019).

Источник финансирования. Работа выполнена в рамках Государственного задания ФГБНУ «Научный центр неврологии».

Конфликт интересов. Авторы декларируют отсутствие явных и потенциальных конфликтов интересов, связанных с публикацией настоящей статьи.

Адрес для корреспонденции: 125367 Москва, Волоколамское ш., д. 80. ФГБНУ «Научный центр неврологии». E-mail: ncnmaximova@mail.ru. Максимова М.Ю.

Для цитирования: Танашян М.М., Максимова М.Ю, Федин П.А., Носкова Т.Ю. Отдалённые результаты лечения нейропатии нижних луночковых нервов после ортогнатической коррекции аномалий и деформаций нижней челюсти. *Анналы клинической и экспериментальной неврологии*. 2023;17(4):35–39.

DOI: https://doi.org/10.54101/ACEN.2023.4.4

Поступила 10.07.2023 / Принята в печать 07.09.2023 / Опубликована 25.12.2023

Introduction

Orthognatic surgery is a routine method to manage mandibular deformities. Its benefits include easier mastication, reduced tenderness in the temporomandibular joints, and better facial esthetics. Necessary osteotomy is performed in close proximity from the inferior alveolar nerve (IAN) [1]. Sensory disorders (numbness or pain in the lower lip, the chin, the teeth, and the gums) are reported in 16.2% of the patients. Though usually temporary, paresthesiae may be permanent [2].

Following orthognatic surgeries for mandibular anomalies and deformities, prevalence of IAN neuropathy varies from 1.3% to 18%. Postoperative sensory disorders in the lower lip and the chin develop in 9–85% of the patients [1, 3, 4].

IAN is often injured as a result of interventions in the mandible and the facial soft tissues or IAN injury [4, 5]. IAN injury may imply full or partial nerve dissection, strain, compression, crush, or ischemia [6]. Depending on the severity of nerve fiber injury, neuropraxia, axonotmesis, or neurotmesis may develop [7]. Damage to the myelin sheath causes demyelination that impairs signal conduction and thus sensitivity. Demyelination of varied severity develops in neuropraxia and axonotmesis [7–9].

Specific IAN injury symptoms include loss of sensitivity in the lower lip on the affected side, the chin, and the gum. When occluding their teeth, the patient feels wrenching pain and discomfort, which affects their quality of life, mastication, speech, and facial expressions while the patient is often unsatisfied with management [1, 2, 10, 11].

Management of traumatic trigeminal neuropathy is a challenge. Physiotherapy is recommended in combination with antidepressants or (rarely) as a single approach. Use of rhythmic transcranial magnetic stimulation (rTMS) is limited with variability of protocols and outcomes [12, 13]. Rhythmic peripheral magnetic stimulation (rPMS) can modulate cortical chain reactions and cortical spinal excitability. Unlike rTMS, rPMS exposes certain body parts rather than their projections on the brain cortex.

Unlike electric stimulation, magnetic stimulation exposes deeper tissues, accelerating neurotransmission and not activating any skin receptors [14, 15].

rPMS is typically used to manage pain and spasticity. However, the published studies covered only a few cases and various protocols [16–18].

Noteworthily, there are no unequivocal recommendations on the use of magnetic stimulation in patients with traumatic trigeminal neuropathy yet [19]. Some studies show that magnetic stimulation relieves pain and accelerates regeneration of the injured nerves [20, 21].

Objective: to assess long-term rPMS outcomes in patients with IAN neuropathy resulting from the surgical treatment of mandibular anomalies and deformities.

Materials and methods

The study included 8 males and 16 females aged 32 ± 12 years with IAN neuropathy following the surgical treatment of mandibular anomalies and deformities [10]. Approved by the Ethics Committee of the Research Center of Neurology (Protocol No. 11/4-19, 11/20/2019), the study continues those published before [10, 22].

Seventeen patients had permanent, similarly intense, aching or contracting pain. The pain was localized individually in the same area: the lower lip, the chin, a mandibular tooth or several mandibular teeth, an alveolar mandibular site. The pain irradiated subzygomatically (posteriorly) in all the patients. Four patients did not feel the painful side of the lower lip they consequently bit when eating or speaking. Besides, the patients complained of gum contracting feeling. Those patients felt hypersthesia with pain, cold, and tactile hyperpathia and warmth hypesthesia in the chin, the lower lip, and the mandibular gum and teeth. In palpation of the pain area, they also felt sharp tenderness. Three patients with IAN neuropathy felt stabbing, burning pain in the lower lip. All the patients reported decreased sensitivity in the IAN innervated area.

Therapeutic rPMS was performed with the Neuro-MS magnetic stimulator (Neurosoft, Ivanovo, Ivanovo Region, Russian Federation). The procedures were performed daily for 15–20 min during 10 days, with 1.0–1.5 T stimuli and 1 Hz frequency. The patients received no pharmaceuticals to stimulate reparation and to improve neurological functions [10].

The patients were followed up in 18±2 months to re-assess long-term rPMS efficiency. Evoked potentials (EPs) including brainstem auditory evoked potentials (BAEPs) and trigeminal EPs (TEPs) were recorded by the Neuro-MEP (Neurosoft, Ivanovo, Ivanovo Region, Russian Federation) [10, 22, 23].

Results

Immediately post 10-day rPMS treatment, 20 patients demonstrated significantly decreased sensory disorders while 4 patients still showed facial paresthesiae. BAEPs changed positively, but TEPs did not change significantly [10, 22].

Table 1. BAEPs before treatment and in 18 ± 2 months after rPMS (median)

Group	Latency, msec			Interpeak interval, msec			Amplitude, μV		
	I	III	V	I–III	III–V	I–V	I	III	V
Normal	1,7 ± 0,1	3,9 ± 0,2	5,7 ± 0,2	2,1 ± 0,2	1,9 ± 0,2	4,0 ± 0,2	0,3 ± 0,1	0,2 ± 0,1	0,4 ± 0,2
Right and left ears:									
post 10-day rPMS treatment	1,6	3,5	5,4	2,0	1,9	3,9	0,3	0,3	0,5
in 18 months post rPMS	1,6	3,6	5,5	2,0	1,9	3,9	0,3	0,3	0,5

Note. I, III, V, BAEP peaks.

Table 2. TEP parameters before and in 18 ± 2 months after rPMS treatment (median)

Group	Threshold, mA	TEP components, msec			Amplitude, μV	
		P1	N1	P2	P1-N1, μV	N1-P2, μV
Normal	5,7	19,2	33,0	49,0	1,9	1,9
Left and right stimulation:						
post 10-day rPMS treatment	5,1	19,8	31,3	43,5	2,0	1,9
in 18 months post rPMS treatment	5,2	20,1	31,7	44,5	2,0	1,9

Clinically, we noted improvement, with reversed sensitivity disorders and better subjective status in 83% of the patients in 18 ± 2 months. BAEPs normalized as well (Table 1), which may indicate rPMS stabilizing general processes and auditory brainstem response.

Post initial 10-day rPMS treatment, TEP changes indicated non-significant bilateral trigeminal dysfunction (Table 2). In 18 ± 2 months, TEPs did not show any negative changes. Therefore, rPMS use contributes to the improvement and the stabilization of the trigeminal system and the brainstem in IAN neuropathy.

Discussion

rPMS is a method of noninvasive stimulation of nerves, muscles, spinal nerve roots, and the autonomic nervous system. rPMS affects excitability of sensory terminals under the coil, which causes functional neuron changes and neuroplasticity. rPMS is relatively painless and may be easily used in clinical setting. Currently, rPMS is widely used for rehabilitation [24].

Magnetic stimulation acts due to the generated magnetic field that induces the electric field, which depolarizes axons. However, the mechanisms of magnetic fields acting to peripheral nerves are still unclear [25, 26]. The effect of the magnetic field on cells may be explained by its impact on the molecular structure of excitable cell membranes followed by the change in the function of insert ion specific channels [27]. Voltage-controlled potassium, sodium, and calcium ion channels are affected by the magnetic field, which makes neurons highly sensitive to the effects of the magnetic field [28–30].

Another possible mechanism is the magnetocaloric effect resulting from magnetic nanoparticle activity in the external magnetic field [31]. Despite lack of evidence for the relation between the magnetocaloric effect and nerve regeneration in the magnetic field, the experimental studies showed that temperature elevation to 37–42ºC may positively affect neuron number increase [32].

The effect of the magnetic field on peripheral nerves is also associated with increase in growth factors and decrease in pro-inflammatory factors. rPMS has vasoprotective, anti-inflammatory, and antiedematic effects and improves trophicity in the injured site. rPMS is getting wider renowned as a method of neuromodulation in sensomotor disorders.

Our earlier study demonstrated efficiency of rPMS in patients with traumatic trigeminal neuropathy. Restored sensitivity as a positive effect of 10-day rPMS treatment significantly improved quality of life in most patients [10, 22].

The positive rPMS outcomes in patients with IAN neuropathy after orthognatic surgeries for mandibular anomalies and deformities in long term (18 ± 2 months) substantiate necessity of this method as part of individual rehabilitation.

Nevertheless, the development of main principles of rPMS use post orthognatic surgeries requires methodological and clinical studies including larger samples.

Список источников / References

1. Agbaje J.O., Salem A.S., Lambrichts I. et al. Systematic review of the incidence of inferior alveolar nerve injury in bilateral sagittal split osteotomy and the assessment of neurosensory disturbances. *Int. J. Oral Maxillofac. Surg* 2015;44:447–451. DOI: 10.1016/j.ijom.2014.11.010
2. Degala S., Shetty S.K., Bhanumathi M. Evaluation of neurosensory disturbance following orthognathic surgery: a prospective study. *J. Maxillofac. Oral Surg* 2015;14: 24–31.
DOI: 10.1007/s12663-013-0577-5
3. Robert R.C., Bacchetti P., Pogrel M.A. Frequency of trigeminal nerve injuries following third molar removal. *J. Oral Maxillofac. Surg* 2005;63:732–735.
DOI: 10.1016/j.joms.2005.02.006
4. Politis C., Sun Y., Lambrichts I., Agbaje J.O. Self-reported hypoesthesia of the lower lip after sagittal split osteotomy. *Int. J. Oral Maxillofac. Surg.* 2013;42:823–829.
DOI: 10.1016/j.ijom.2013.03.020
5. Yamauchi K., Takahashi T., Kaneuji T. et al. Risk factors for neurosensory disturbance after bilateral sagittal split osteotomy based on position of mandibular canal and morphology of mandibular angle. *J. Oral Maxillofac. Surg.* 2011;70:401–406. DOI: 10.1016/j.joms.2011.01.040
6. Wijbenga J.G., Verlinden C.R., Jansma J. et al. Long-lasting neurosensory disturbance following advancement of the retrognathic mandible: distraction osteogenesis versus bilateral sagittal split osteotomy. *Int. J. Oral Maxillofac. Surg.* 2009;38:719–725. DOI: 10.1016/j.ijom.2009.03.714

7. Carballo Cuello C.M., De Jesus O. Neurapraxia. In: StatPearls.Treasure Island; 2023.
8. Teerijoki-Oksa T., Jääskeläinen S.K., Soukka T. et al. Subjective sensory symptoms associated with axonal and demyelinating nerve injuries after mandibular sagittal split osteotomy. *Oral Maxillofac. Surg.* 2011;69(6):e208–e213. DOI: 10.1016/j.joms.2011.01.024
9. Korczeniewska O.A., Kohli D., Benoliel R. et al. pathophysiology of post-traumatic trigeminal neuropathic pain. *Biomolecules.* 2022;12(12):1753. DOI: 10.3390/biom12121753
10. Танашян М.М., Максимова М.Ю., Федин П.А. и др. Диагностика и лечение травматической невропатии тройничного нерва. Анналы клинической и экспериментальной неврологии 2018;12(2):22–26. Tanashyan M.M., Maximova M.Yu., Fedin P.A. et al. Diagnosis and management of traumatic neuropathy. Annals of clinical and experimental neurology. 2018;12(2):22–26 DOI: 10.18454/ACEN.2018.2.3
11. D'Agostino A., Trevisiol L., Gugole F. et al. Complications of orthognathic surgery: the inferior alveolar nerve. *J. Craniofac. Surg.* 2010;21(4):1189–1195. DOI: 10.1097/SCS.0b013e3181e1b5ff
12. Guerra A, López-Alonso V, Cheeran B, Suppa A. Variability in non-invasive brain stimulation studies: Reasons and results. *Neurosci. Lett.* 2020;719:133330. DOI: 10.1016/j.neulet.2017.12.058
13. Пойдашева А.Г., Синицын Д.О., Бакулин И.С. и др. Структурные и функциональные биомаркеры эффекта навигационной ритмической транскраниальной магнитной стимуляции у пациентов с фармакорезистентной депрессией. *Неврология, нейропсихиатрия, психосоматика.* 2022;14(4):12–19. Poydasheva A.G., Sinitsyn D.O., Bakulin I.S. et al. Structural and functional biomarkers of the effect of navigational repetitive transcranial magnetic stimulation in patients with drug-resistant depression. *Neurology, Neuropsychiatry, Psychosomatics.* 2022;14(4):12–19. DOI: 10.14412/2074-2711-2022-4-12-19
14. Struppler A., Angerer B., Gundisch C., Havel P. Modulatory effect of repetitive peripheral magnetic stimulation on skeletal muscle tone in healthy subjects stabilization of the elbow joint. *Exp. Brain Res.* 2004;157(1):59–66. DOI: 10.1007/s00221-003-1817-6
15. Золотухина Е.И, Улащик В.С. Основы импульсной магнитотерапии: пособие. Витебск; 2012. 144 с. Zolotukhina E.I., Ulashchik V.S. Fundamentals of pulsed magnetotherapy: a manual. Vitebsk; 2012. 144 p.
16. Krause P., Straube A. Peripheral repetitive magnetic stimulation induces intracortical inhibition in healthy subjects. *Neurol. Res.* 2008;30(7):690–694. DOI: 10.1179/174313208X297959
17. Меркулов Ю.А., Гореликов А.Е., Пятков А.А., Меркулова Д.М. Ритмическая трансспинальная магнитная стимуляция в терапии хронической боли в нижней части спины. Метаанализ (Часть II). *Патологическая физиология и экспериментальная терапия.* 2021;65(4):97–108. Merkulov Y.A., Gorelikov A.E., Pyatkov A.A., Merkulova D.M. Repetitive transspinal magnetic stimulation in the treatment of chronic low back pain. A meta-analysis (Part II). *Pathological Physiology and Experimental Therapy, Russian Journal.* 2021;65(4):97–108. DOI: 10.25557/0031-2991.2021.04.97-108
18. Khedr E.M., Ahmed M.A., Alkady E.A. et al. Therapeutic effects of peripheral magnetic stimulation on traumatic brachial plexopathy: clinical and neurophysiological study. *Neurophysiol. Clin.* 2012;42(3):111–118. DOI: 10.1016/j.neucli.2011.11.003
19. Stidd D.A., Wuollet A.L., Bowden K. et al. Peripheral nerve stimulation for trigeminal neuropathic pain. *Pain Physician.* 2012;15(1):27–33.
20. Мусаев А.В., Гусейнова С.Г., Мустафаева Э.Э. Высокоинтенсивная магнитная стимуляция в реабилитации больных с травматическими поражениями нервов верхних конечностей. *Физиотерапия, бальнеология и реабилитация* 2010;3:14–17. Musaev A.V., Huseynova S.G., Mustafayeva E.E. High-intensity magnetic stimulation in the rehabilitation of patients with traumatic lesions of the nerves of the upper extremities. *Physiotherapy, balneology and rehabilitation.* 2010;3:14–17.
21. Mert T., Gunay I., Gocmen C. et al. Regenerative effects of pulsed magnetic field on injured peripheral nerves. *Altern. Ther. Health Med.* 2006;12(5):42–49.
22. Танашян М.М., Максимова М.Ю., Иванов С.Ю. и др. Невропатия тройничного нерва после ортогнатических операций. *Неврология, нейропсихиатрия, психосоматика.* 2020;12(4):37–42. Tanashyan M.M., Maksimova M.Yu., Ivanov S.Yu. et al. Trigeminal neuropathy following orthognathic surgery. *Neurology, Neuropsychiatry, Psychosomatics.* 2020;12(4):37–42. DOI: 10.14412/2074-2711-2020-4-37-42
23. Максимова М.Ю., Федин П.А., Суанова Е.Т., Тюрников В.М. Нейрофизиологические особенности атипичной лицевой боли. *Анналы клинической и экспериментальной неврологии.* 2013;7(3):9–16. Maksimova M.Yu., Fedin P.A., Suanova E.T., Tyurnikov V.M. [Neurophysiological features of atypical facial pain. *Annals of clinical and experimental neurology.* 2013;7(3):9–16.
24. Jiang Y.F., Zhang D., Zhang J. et al. A randomized controlled trial of repetitive peripheral magnetic stimulation applied in early subacute stroke: effects on severe upper-limb impairment. *Clin. Rehabil.* 2022;36(5):693–702. DOI: 10.1177/02692155211072189
25. Gallasch E., Christova M., Kunz A. et al. Modulation of sensorimotor cortex by repetitive peripheral magnetic stimulation. *Front. Hum. Neurosci.* 2015;9:407. DOI: 10.3389/fnhum.2015.00407
26. Fan Z., Wen X., Ding X. et al. Advances in biotechnology and clinical therapy in the field of peripheral nerve regeneration based on magnetism. *Front. Neurol.* 2023;14:1079757. DOI: 10.3389/fneur.2023.1079757
27. Rosen A.D. Mechanism of action of moderate-intensity static magnetic fields on biological systems. *Cell Biochem. Biophys.* 2003;39(2):163–173. DOI: 10.1385/CBB:39:2:163
28. Mathie A., Kennard L.E., Veale E.L. Neuronal ion channels and their sensitivity to extremely low frequency weak electric field effects. *Radiat. Prot. Dosimetry.* 2003;106(4):311–316. DOI: 10.1093/oxfordjournals.rpd.a006365
29. Marchionni I., Paffi A., Pellegrino M. et al. Comparison between low-level 50 Hz and 900 MHz electromagnetic stimulation on single channel ionic currents and on firing frequency in dorsal root ganglion isolated neurons. *Biochim. Biophys. Acta* 2006;1758(5):597–605. DOI: 10.1016/j.bbamem.2006.03.014
30. Saunders R.D., Jefferys J.G.R. A neurobiological basis for ELF guidelines. *Health Phys.* 2007;929(6):596–603. DOI: 10.1097/01.HP.0000257856.83294.3e
31. Lin T.C., Lin F.H., Lin J.C. In vitro feasibility study of the use of a magnetic electrospun chitosan nanofiber composite for hyperthermia treatment of tumor cells. *Acta Biomater.* 2012;8:2704–2711. DOI: 10.1016/j.actbio.2012.03.045
32. Cancalon P. Influence of temperature on various mechanisms associated with neuronal growth and nerve regeneration. *Prog. Neurobiol.* 1985;25(1):27–92. DOI: 10.1016/0301-0082(85)90022-x

Information about the authors

Marine M. Tanashyan — D. Sci. (Med.), Prof., Deputy director for scientific research work, Head, 1st Neurology department, Institute of Clinical and Preventive Neurology, Research Center of Neurology, Moscow, Russia, https://orcid.org/0000-0002-5883-8119
Marina Yu. Maksimova — D. Sci. (Med.), Prof., Head, 2nd Neurology department, Institute of Clinical and Preventive Neurology, Research Center of Neurology, Moscow, Russia; Professor, Department of nervous diseases, A.I. Evdokimov Moscow State University of Medicine and Dentistry, Moscow, Russia, https://orcid.org/0000-0002-7682-6672
Pavel A. Fedin — Cand. Sci. (Med.), leading researcher, Laboratory of clinical neurophysiology, Research Center of Neurology, Moscow, Russia, https://orcid.org/0000-0001-9907-9393
Tatiana Yu. Noskova — Cand. Sci. (Med.), senior researcher, Scientific and Consulting Department, Research Center of Neurology, Moscow, Russia, https://orcid.org/0000-0002-1634-1497

Author contribution: *Tanashyan M.M.* — concept and design of the study, collection of material, writing the text of the article, scientific editing; *Maksimova M.Yu.* — concept and design of the study, collection of material, writing the text of the article; *Fedin P.A., Noskova T.Yu.* — neurophysiological studies, statistical processing of materials.

Информация об авторах

Танашян Маринэ Мовсесовна — д.м.н., проф., член-корреспондент РАН, зам. директора по научной работе, руководитель 1-го неврологического отд. Института клинической и профилактической неврологии ФГБНУ НЦН, Москва, Россия, https://orcid.org/0000-0002-5883-8119
Максимова Марина Юрьевна — д.м.н., профессор, руководитель 2-го неврологического отделения Института клинической и профилактической неврологии ФГБНУ НЦН; профессор каф. нервных болезней МГМСУ им. А.И. Евдокимова, Москва, Россия, https://orcid.org/0000-0002-7682-6672.
Федин Павел Анатольевич — к.м.н., в.н.с. лаб. клинической нейрофизиологии ФГБНУ НЦН, Москва, Россия, https://orcid.org/0000-0001-9907-9393
Носкова Татьяна Юрьевна — к.м.н., с.н.с. научно-консультативного отделения ФГБНУ НЦН, Москва, Россия, https://orcid.org/0000-0002-1634-1497

Вклад авторов: *Танашян М.М.* — концепция и дизайн исследования, сбор материала, написание текста статьи, научное редактирование; *Максимова М.Ю.* — концепция и дизайн исследования, сбор материала, написание текста статьи; *Федин П.А., Носкова Т.Ю.* — нейрофизиологические исследования, статистическая обработка материалов.