Genij Ortopedii. 2023;29(1)7-11.

Original article

https://doi.org/10.18019/1028-4427-2023-29-1-7-11

The effectiveness of endoscopic brachial plexus neurolysis in the treatment of brachial plexus palsy in adults

R.H. Sagdiev[1,2], S.S. Dydykin[1], A.G. Shapkin[2], R.A. Sufianov[2], S.V. Lyulin[3], D.Yu. Borzunov[4,5], A.A. Sufianov[1,2]✉

[1] Sechenov First Moscow State Medical University (Sechenov University), Moscow, Russian Federation
[2] Federal Center for Neurosurgery, Tyumen, Russian Federation
[3] Medical Center Carmel, Chelyabinsk, Russian Federation
[4] Ural State Medical University, Ekaterinburg, Russian Federation
[5] Central City Clinical Hospital No. 23, Ekaterinburg, Russian Federation

Corresponding author: Albert A. Sufianov, sufianov@gmail.com

Abstract

Introduction The method of endoscopic revision, neurolysis and decompression of the brachial plexus is a current minimally invasive method of treatment. It is able to completely preserve the anatomical structures (skin, fascia, muscles, clavicle, arteries, veins, nerves) and minimize damage to the structures of the brachial plexus, since neurolysis is carried out along the trunks and bundles of the plexus through a low-invasive transaxillary approach. However, the effectiveness of this type of operation has not been studied previously. **The aim of the study** To evaluate the effectiveness of brachial plexus neurolysis under video endoscopic assistance in the treatment of brachioplexopathies in adults **Materials and methods** The study involved patients hospitalized in the Tyumen Federal Center for the period from 2017 to 2022 with a diagnosis of brachial plexus palsy, who, for medical reasons, underwent neurolysis of the brachial plexus under video endoscopic assistance. The number of patients gave informed concent was 25 subjects. The results of treatment were assessed with score systems and questionnaires; neurological examination was performed and muscle strength was assessed according to the British scale (M5-M0), the type of sensory disorders and their degree on a scale from 0 to 10, where 10 is the complete preservation of sensitivity, and 0 is its complete absence and were confirmed by the data of functional diagnostics (stimulation ENMG) 3, 6 and 12 months after the operation. Statistical data processing was carried out using the Microsoft Excel (Microsoft Office 365) and Stattech 2.0 software package. For quantitative traits, the arithmetic mean (M) and standard error of the mean (SEM) were calculated. To assess the statistical significance of the results obtained, the parametric t-Student's test was used. Differences were considered significant at $p < 0.05$. **Results** The mean age of the patients was 48 ± 15 years, gender ratio (m/f) was 18/7, the affected side (right/left) ratio was 12/13. A positive result was achieved in 75 % of cases (n = 19), the absence of positive dynamics was noted in 25 % of cases (n = 6); there were no cases of poor results. When comparing the indicators in groups with a positive result and its absence, it was revealed that the degree of limb dysfunction and the degree of paresis affect the treatment outcome ($p < 0.05$). In all patients with a positive result, a positive trend was observed starting from 5.89 ± 0.93 (range 1-15) weeks after surgery. **Conclusion** The proposed method of neurolysis of the brachial plexus is an effective method for the treatment of patients with brachial plexus palsy of various etiologies. The main factor influencing the outcome of reatment is limb dysfunction, the severity of which is inversely proportional to the function recovery in the postoperative period. Based on the results obtained, neurolysis was not effective in paresis of the affected muscles scoring 0-1 points. If there is no positive effect from the intervention within 3 months after its implementation, further waiting tactics is not advisable. Other treatment options should be considered.

Keywords: brachial plexus, brachial plexus palsy, neurolysis, endoscope, limb function

For citation: Sagdiev RH, Dydykin SS, Shapkin AG, Sufianov RA, Lyulin SV, Borzunov DYu, Sufianov AA. The effectiveness of endoscopic brachial plexus neurolysis in the treatment of brachial plexus palsy in adults. *Genij Ortopedii*. 2023;29(1):7-11. doi: 10.18019/1028-4427-2023-29-1-7-11

INTRODUCTION

The incidence of peripheral nerve diseases, including traumatic injuries, has been growing every year. However, the surgery for this pathology remains one of the least studied areas in the current medicine.

Brachioplexopathies occupy a leading place among injuries of the nerve trunks of the upper limb [1]. In ost cases, persons of working age have been affected [2-6], mostly males [2-5]. Permanent disability reaches 60-80 % [7-9], thereby causing not only medical, but also social and economic problems. Dysfunctions of the limb resulting from partial nerve damage develop in 60 % of the affected persons [10]. Combined injuries in traumatic brachioplexopathies are encountered in 54-70 % [2, 11, 12].

It is worth noting a significant breakthrough in peripheral nerve surgery among the positive trends over the past decades. The method for endoscopic revision, neurolysis and decompression of the brachial plexus was developed [13]. The method is able to fully preserve the anatomical structures (skin, fascia, muscles, collarbone, arteries, veins, nerves), minimize damage to the structures of the brachial plexus, since neurolysis is carried out along the trunks and bundles of the plexus through a low-traumatic transaxillary approach. All this ensures rapid rehabilitation of patients, reduction of the duration of inpatient treatment, low intensity of postoperative pain. However, the effectiveness of this type of operation has not been studied previously.

The aim of the study was to assess the effectiveness of a proposed method of brachial plexus neurolysis for endoscopically assisted management of brachioplexopathies in adults.

MATERIALS AND METHODS

Patients

The study included patients hospitalized in the Tyumen Federal Center for Neurosurgery in the period from 2017 to 2022 with a diagnosis of brachioplexopathy, who, for medical reasons, underwent brachial plexus neurolysis under video endoscopic assistance. Twenty-five subjects underwent surgical treatment. The study was approved by the local ethical committee of Sechenov University, protocol No. 04-21. All patients signed informed consent for the study. The inclusion criterion for patients in the study was age over 18 years; the exclusion criterion: severe degenerative changes in the cervical spine with secondary vertebrogenic myelopathy, casting doubt on the diagnosis of brachioplexopathy.

Indications for surgery regarded by this study:

1) established diagnosis of brachioplexopathy on the basis of complaints, anamnesis, and examination tests;

2) absence of reliable signs of violation of the anatomical integrity of the structures of the brachial plexus according to investigation findings;

3) incomplete restoration of the function of the affected limb after adequate conservative treatment within 3-6 months before hospitalization;

4) significant dysfunction of the upper limb, reducing the quality of life of the patient.

Preoperative examination

All patients were examined at admission according to the standards.

A neurological examination was performed to determine muscle strength according to the British scale (M5-M0), the type of sensory impairments and their grade on a scale from 0 to 10 where 10 is a complete preservation of sensitivity, and 0 is its complete absence [14].

The following scales and questionnaires were used: Disabilities of the arm, shoulder and hand (DASH) questionnaire, the Numerological Pain Rating Scale (VAS) [14]. Stimulation ENMG and MRI of the brachial plexus were performed (if there were contraindications, CT myelography was performed) in order to exclude violations of the anatomical integrity of the structures of the brachial plexus.

Surgical techniques

Under endotracheal anesthesia and the patient in the supine position with the arm extended to the side in the armpit, an incision was made along the skin fold so that the projection of the neurovascular bundle of the shoulder was in the center of the incision (Fig. 1).

After exposure the axillary fascia, the neurovascular bundle was isolated, the nerves, arteries and veins were identified in it, and they were fixed on holders. Next, a retractor with optics was inserted into the wound parallel to the neurovascular bundle. Further actions were performed under the control of endoscopic optics and with the help of instruments for endoneurolysis. Gradually moving the endoscopic retractor along the neurovascular structures, the adhesions were separated and the structures of the brachial plexus were released from the surrounding tissues, starting distally from the level of the branch of the terminal branches and ending proximally at the place where the roots enter the intervertebral foramina (Fig. 2). The operation ran under neurophysiological control.

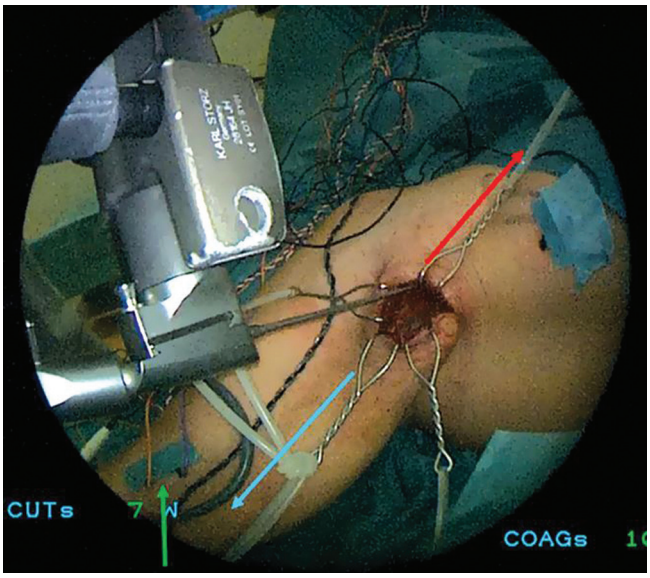

Fig. 1 View of the wound before inserting the endoscope into the endoscopic retractor. The red arrow indicates the proximal direction and the blue arrow indicates the distal direction. The green arrow indicates the electrodes for neurophysiological control

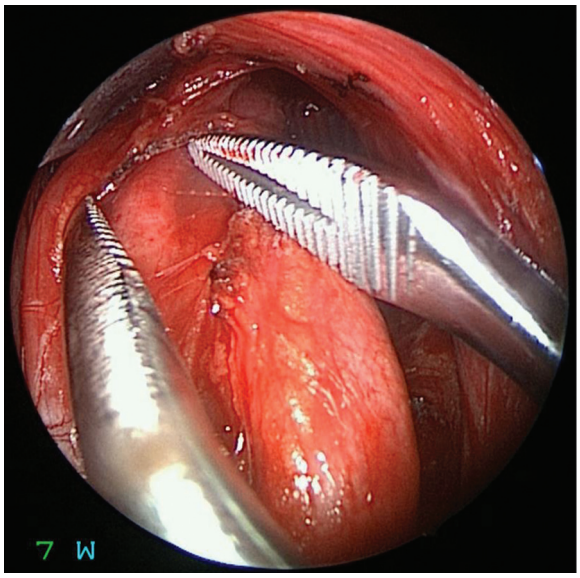

Fig. 2 Endoscopic view of the structures of the brachial plexus during the main stage of the operation (diameter of the working part 4 mm, optics direction angle 0 degrees)

Interpretation of possible results

The results of treatment were assessed with evaluation scales and questionnaires, neurological examination and confirmed by functional diagnostic data (stimulation ENMG) after 3, 6 and 12 months post-surgery. At neurological examination, three parameters were separately assessed: strength, sensory disorders and pain. A positive result in paresis of 3 points was considered an increase in the strength up to 4-5 points; in paresis of 0-2 points, an increase in strength up to 3-5 points was considered a positive result. Sensitivity disorders were assessed on a scale from 0 to 10; an improvement in sensitivity by 1 point or more was considered a positive result. Pain was assessed using the VAS scale; a decrease in pain by 50 % or more was considered a positive result.

Statistical analysis

Statistical data processing was carried out using the Microsoft Excel (Microsoft Office 365) and Stattech 2.0 software package. For quantitative traits, the arithmetic mean (M) and standard error of the mean (SEM) were calculated. To assess the statistical significance of the results obtained, the parametric Student's t-test was used. Differences were considered significant at $p < 0.05$.

RESULTS

The mean age of the patients was 48 ± 15 years, the sex ratio (M/F) was 18/7, and the affected side (right/left) was 12/13. The main causes of brachioplexopathy in the main group were a fall on the arm (6 patients, 24 % of cases), dislocation of the shoulder joint (6 patients, 24 %), and traffic accident (5 patients, 20 %) (Table 1).

Table 1

Causes of brachioplexypathy in the patients

Cause	Number of cases	
	абс.	%
Traffic accident	5	20
Fall on the arm	6	24
Shoulder dislocation	6	24
Knife wound	1	4
Iatrogenic	4	16
Idiopathic brachioplexopathy	3	12
Total	25	100

A positive result was achieved in 76 % of cases (n = 9), the absence of positive dynamics was noted in 24 % of clinical cases (n = 6); there were no treatment outcomes with a negative result. In order to identify factors influencing the result of the operation, we compared the main indicators before the operation in patients with a positive result and its absence (Table 2).

Table 2

Comparison of the main indicators before the operation in patients with a positive result and its absence

Parameter	Cases of positive result (M ± SEM)	Cases without positive result (M ± SEM)	p-value
Paresis	2.7 ± 0.2	0.8 ± 0.4	< 0.05
Disorders in sensitivity	6.1 ± 1.5	5.5 ± 3.1	> 0.05
DASH	45.4 ± 3.5	79.3 ± 3.6	< 0.05
VAS	3.1 ± 1	2.6 ± 1.3	> 0.05

An important clinical aspect is the timing of limb function recovery after surgery. According to our study, in all patients with a favorable result, a positive dynamics was observed starting from 5.89 ± 0.93 (range 1-15) weeks after surgery.

DISCUSSION

The history of endoscope application in brachial plexus surgery began not so long ago, from the 90^s of the last century with the first experiment to revise the roots of the brachial plexus under endoscopic assistance [15]. Later K.G. Krishnan, having conducted studies on cadavers, was one of the first to propose revision of the brachial plexus as a diagnostic operation aimed at identifying the degree of brachial plexus damage and planning further treatment tactics; the main anatomical landmarks for its performance through supraclavicular and subclavian approaches were defined [16]. A similar study, but using robotic technology, was carried out by G. Mantovani in 2011 on two brachial plexuses on one fresh unopened corpse [17].

The first case of endoscopic revision of the brachial plexus on a living person reported in the literature was described in 2006, when a patient with a closed brachial plexus injury after a traffic accident underwent this operation. He completely recovered the strength and sensitivity in the affected arm after six months [18].

Subsequently, resection of the first rib for the syndrome of the superior thoracic outlet, which has been carried out since 1910, was first proposed to be performed under video endoscopic assistance in 2007 [19].

In 2017, Lafosse et al. proposed an original method for performing neurolysis of all parts of the brachial plexus in patients with upper thoracic outlet syndrome [20]. Later, in 2020, the same group of scientists proved the effectiveness of this method in the treatment of adult patients with brachioplexopathy resulting from shoulder joint dislocation, and subsequently proposed an algorithm for managing patients [21].

In 2021, a group of scientists proposed a method of endoscopic revision and neurolysis of the brachial plexus, which enables, if necessary, to perform interventions on the shoulder joint what is relevant in patients with co-morbidities [22]. Based on the above studies, it is currently possible to divide the methods of endoscopic neurolysis of the brachial plexus into several types.

1. Neurolysis of the brachial plexus under video endoscopic assistance.

2. Fully endoscopic neurolysis of the brachial plexus, including robot-assisted.

The second method has been studied, its effectiveness has been proven in clinical practice, but the first method, according to the literature, was used once and needs to be studied. The method used in our study is a variant of the first method. Thus for the first time it was carried out on a statistically significant group of patients with different etiologies of brachioplexopathy and varying severity. Moreover, it was possible to clarify the criteria for selecting patients for this type of operation and to determine the waiting time for a positive result in the postoperative period.

In recent years, there has been tremendous progress in surgical methods for the treatment of lesions of the brachial plexus [23, 24]. However, the problem of complete restoration of the function of the upper limb remains relevant, that we had to face in our study. There have been studies that determined the optimal timing for surgery [24, 25, 26], as well as factors that initially worsen the prognosis of treatment, such as lack of rehabilitation in the postoperative period [27, 28], overweight [29, 30, 31] and the age of the patient [32], based on which we recommend paying attention to those factors in order to improve tha recovery of the function of the upper limb.

1. If the anatomical integrity of the nervous structures is broken, spontaneous recovery is impossible; therefore, surgical intervention is required without delay.

2. In the absence of evident signs of anatomical disintegration of the nervous structures, conservative treatment is recommended within 3 to 6 months after the development of brachioplexopathy. If it is ineffective, surgical treatment should be carried out no later than 6 to 7 months after the development of brachioplexopathy. Otherwise, the effectiveness of operations on nervous structures sharply decreases, and the restoration of limb function is possible only with the help of reconstructive and orthopedic interventions.

3. Rehabilitation before and after surgery significantly increases the chances of recovery.

CONCLUSION

The proposed method of brachial plexus neurolysis is an effective method for treating patients with brachioplexopathies of various etiologies. The main factor influencing the outcome of treatment is limb dysfunction, the severity of which is inversely proportional to functional recovery in the postoperative period. Based on the results obtained, neurolysis was not effective in paresis of the affected muscles within the range of 0-1 points. In the absence of a positive effect from the operation, the waiting tactics is not advisable within three months after the operation. Other treatment options should be considered.

REFERENCES

1. Aitemirov ShM, Ninel VG, Korshunova GA, Shchanitsyn IN. High-resolution ultrasonography in the diagnosis and management of peripheral nerve lesions (review). *Travmatologiya i ortopediya Rossii*. 2015;(3):116-125. (In Russ.)
2. Faglioni W, Siqueira MG, Martins RS, Heise CO, Foroni L. The epidemiology of adult traumatic brachial plexus lesions in a large metropolis. *Acta Neurochir*. 2014;156(5):1025-1028. doi: 10.1007/s00701-013-1948-x
3. Songcharoen P. Brachial plexus injury in thailand: a report of 520 cases. *Microsurgery*. 1995;16(1):35-39. doi: 10.1002/micr.1920160110
4. Kim DH, Cho Y-J, Tiel R, Kine D. Outcomes of surgery in 1019 brachial plexus lesions treated at Louisiana State University Health Sciences Center. *J Neurosurg*. 2003;98(5):1005-1016. doi: 10.3171/jns.2003.98.5.1005
5. Li G, Xue M, Wang J, Zeng X, Qin J, Sha K. Traumatic brachial plexus injury : a study of 510 surgical cases from multicenter services in Guangxi, China. *Acta Neurochir*. (Wien). 2019;161(5):899-906. doi: 10.1007/s00701-019-03871-y
6. Jain DK, Bhardwaj P, Venkataramani H, Sabapathy SR. An epidemiological study of traumatic brachial plexus injury patients treated at an Indian Centre. *Indian J Plast Surg*. 2012;45(3):498-503. doi: 10.4103/0970-0358.105960
7. Bogov AA, Khannanova IG. Tactics of surgical treatment of injuries of the brachial plexus. *Prakticheskaya meditsina*. 2008;(1):64-66.
8. Shevelev IN. *Traumatic lesions of the brachial plexus (diagnosis, microsurgery)*. M., 2005, 383 p.
9. Kim DH, Cho Y-J, Tiel RL, Kline DG. Outcomes of surgery in 1019 brachial plexus lesions treated at Louisiana Health Sciences Center. *J Neurosurg*. 2003;98(5):1005-1016. doi: 10.3171/jns.2003.98.5.1005
10. Strelis LP, Levitsky EF, Abdulkina NG, Laptev BI. *Physiotherapy of injuries of peripheral nerves*. Tomsk, Red Banner. 2001. 270 p.
11. Midha R. Epidemiology of brachial plexus injuries in a multitrauma population. Neurosurgery, 1997;4(6):1182-1189.
12. Kaiser R, Mencl L, Haninec P. Injuries associated with serious brachial plexus involvement in polytrauma among patients requiring surgical repair. *Injury*. 2014;45(1):223-226. doi: 10.1016/j.injury.2012.05.013
13. Sufianov AA, Gizatullin MR, Yakimov YA. Russian Federation. [The method of endoscopic revision, neurolysis and decompression of the brachial plexus]. Patent RF, no. 2637616C1, 2017.
14. Shin AY, Pulos N. *Operative Brachial Plexus Surgery*. Springer Nature Switzerland, 2021. 639 p.
15. Monsivais JJ, Narakas AO, Turkof E, Sun Y. The endoscopic diagnosis and possible treatment of nerve root avulsions in the management of brachial plexus injuries. *J Hand Surg Br*. 1994;19(5):547-549. doi: 10.1016/0266-7681(94)90111-2

16. Krishnan KG, Pinzer T, Reber F, Schackert G. Endoscopic exploration of the brachial plexus: technique and topographic anatomy – a study in fresh human cadavers. *Neurosurgery*. 2004;54(2):401-409. doi: 10.1227/01.neu.0000103423.08860.a9
17. Mantovani G, Liverneaux P, Garcia JC Jr, Berner SH, Bednar MS, Mohr CJ. Endoscopic exploration and repair of brachial plexus with telerobotic manipulation: a cadaver trial. *J Neurosurg*. 2011;115(3):659-664. doi: 10.3171/2011.3.JNS10931
18. Braga-Silva J, Gehlen D, Kuyven CR. Endoscopic exploration of a brachial plexus injury. *J Reconstr Microsurg*. 2006;22(7):539-541. doi: 10.1055/s-2006-951320
19. Abdellaoui A, Atwan M, Reid F, Wilson P. Endoscopic assisted transaxillary first rib resection. *Interact Cardiovasc Thorac Surg*. 2007 Oct;6(5):644-646. doi: 10.1510/icvts.2007.151423
20. Lafosse T, Le Hanneur M, Lafosse L. All-endoscopic brachial plexus complete neurolysis for idiopathic neurogenic thoracic outlet syndrome: a prospective case series. *Arthroscopy*. 2017 Aug;33(8):1449-1457. doi: 10.1016/j.arthro.2017.01.050
21. Le Hanneur M, Colas M, Serane-Fresnel J, Lafosse L, Grandjean A, Silvera J, Lafosse T. Endoscopic brachial plexus neurolysis in the management of infraclavicular nerve injuries due to glenohumeral dislocation. *Injury*. 2020 Nov;51(11):2592-2600. doi: 10.1016/j.injury.2020.08.005
22. Belyak E, Lazko F, Prizov A, Lazko M, Maglaperidze I. [Clinical case of endoscopic brachial plexus decompression in a patient with rotator cuff rupture and post traumatic plexopathy]. *Georgian Med News*. 2021 Jul-Aug;(316-317):30-35. (In Russ.)
23. Siqueira MG, Malessy MJA. Traumatic brachial plexus lesions: clinical and surgical aspects. In: *Treatment of peripheral nerve lesions*. Prism Books. 2011. p. 93–110.
24. Bertelli JA, Ghizoni MF. Results and current approach for Brachial Plexus reconstruction. *J Brachial Plex Peripher Nerve Inj*. 2011 Jun 16;6(1):2. doi: 10.1186/1749-7221-6-2
25. Siquiera MG, Martins R, Heisse O, Socolovsky M. Lesiones traumáticas del plexo braquial e adultos: Parte 1. Mecanismos de lesión, métodos diagnósticos e indicaciones del tratamiento quirúrgico. In: *Neurocirugía, Aspectos Clínicos y Quirurgícos*, 1st Ed. Corpus. 2010.
26. Millesi H. Update on the treatment of adult brachial plexus injuries. In: *Brachial plexus injuries*. Martin Dunitz Ltd. 2001.
27. Socolovsky M, Di Masi G, Battaglia D. Use of long autologous nerve grafts in brachial plexus reconstruction: factors that affect the outcome. *Acta Neurochir* (Wien). 2011 Nov;153(11):2231-2240. doi: 10.1007/s00701-011-1131-1
28. Socolovsky M, di Masi G, Bonilla G, Domínguez Paez M, Robla J, Calvache Cabrera C. The phrenic nerve as a donor for brachial plexus injuries: is it safe and effective? Case series and literature analysis. *Acta Neurochir* (Wien). 2015 Jun;157(6):1077-1086; discussion 1086. doi: 10.1007/s00701-015-2387-7
29. Elhassan B, Bishop AT, Hartzler RU, Shin AY, Spinner RJ. Tendon transfer options about the shoulder in patients with brachial plexus injury. *J Bone Joint Surg Am*. 2012 Aug 1;94(15):1391-1398. doi: 10.2106/JBJS.J.01913
30. Socolovsky M, Di Masi G, Bonilla G, Malessy M. Spinal to accessory nerve transfer in traumatic brachial plexus palsy: is body mass index a predictor of outcome? *Acta Neurochir* (Wien). 2014 Jan;156(1):159-163. doi: 10.1007/s00701-013-1896-5
31. Socolovsky M, Martins RS, Di Masi G, Bonilla G, Siqueira MG. Influence of body mass index on the outcome of brachial plexus surgery: are there any differences between elbow and shoulder results? *Acta Neurochir* (Wien). 2014 Dec;156(12):2337-2344. doi: 10.1007/s00701-014-2256-9
32. Socolovsky M, di Masi G, Bonilla G, Lovaglio AC, López D. Age as a Predictor of Long-Term Results in Patients with Brachial Plexus Palsies Undergoing Surgical Repair. *Oper Neurosurg* (Hagerstown). 2018 Jul 1;15(1):15-24. doi: 10.1093/ons/opx184

The article was submitted 03.11.2022; approved after reviewing 21.11.2022; accepted for publication 16.12.2022.

Information about authors:

1. Ranel H. Sagdiev – Ranel313@yandex.ru, https://orcid.org/0000-0003-3295-6632;
2. Sergey S. Dydykin – Doctor of Medical Sciences, professor, dydykin_ss@mail.ru, https://orcid.org/0000-0002-1273-0356;
3. Andrey G. Shapkin – Ph.D. in Medicine, https://orcid.org/0000-0001-6216-0825;
4. Rinat A. Sufianov – sufianov_r_a@staff.sechenov.ru, https://orcid.org/0000-0003-4031-0540;
5. Sergey V. Lyulin – Doctor of Medical Sciences, carmel74@yandex.ru, https://orcid.org/0000-0002-2549-1059;
6. Dmitry Yu. Borzunov – Doctor of Medical Sciences, borzunov@bk.ru, https://orcid.org/0000-0003-3720-5467;
7. Albert A. Sufianov – Doctor of Medical Sciences, professor, sufianov@gmail.com, https://orcid.org/0000-0001-7580-0385.

Conflict of interest *Not declared.*
Funding *Not declared.*