Case Report

https://doi.org/10.23934/2223-9022-2023-12-2-282-290

Experience of Endoscopic Transcapsular Axillary Nerve Decompression

E.A. Belyak[1, 2] ✉, S.A. Asratyan[1], M.F. Lazko[1, 2], F.L. Lazko[1, 2], D.L. Paskhin[1], A.P. Prizov[1, 2], D.S. Smirnov[1]

Department of Traumatology and Orthopedics
[1] V.M. Buyanov Moscow City Clinical Hospital
26 Bakinskaya Str., 115516, Moscow, Russian Federation
[2] Peoples' Friendship University of Russia
6 Miklukho-Maklaya Str., 117198, Moscow, Russian Federation

✉ **Contacts:** Evgeny A. Belyak, Candidate of Medical Sciences, Traumatologist-Orthopedist, Department of Traumatology and Orthopedics, V.M. Buyanov Moscow City Clinical Hospital.
Email: belyakevgen@mail.ru

INTRODUCTION Posttraumatic axillary nerve neuropathy is a widely spread pathology, more often seen after shoulder joint trauma. It can also occur as a complication after orthopaedic surgeries, for example, after Latarjet procedure for shoulder stabilization. The technique of open axillary nerve decompression is very popular but has a number of disadvantages: large trauma of soft tissue, severe bleeding, high rate of complications, poor cosmetic effect. Endoscopic surgical technique of decompression is an effective, less traumatic alternative to open procedures.

AIM To improve the outcomes of treatment of patients with axillary nerve neuropathy.

MATERIAL AND METHODS We present the outcomes of endoscopic transcapsular axillary nerve decompression in 5 patients with a clinical picture of neuropathic pain syndrome, hypoesthesia in the deltoid area, hypotrophy of the deltoid muscle, who were operated from 2018 to 2021. The mean age of the patients was 44.4±14.9. An original surgical technique of decompression, which included arthroscopy of the shoulder joint with diagnostic and treatment components and transcapsular endoscopic axillary nerve decompression in the beach-chair position, was developed and applied to all the patients. Statistical analysis was performed using the MannWhitney U test.

RESULTS According to VAS-scale, the severity of pain syndrome before the surgery was 6±4.6 points, 6 months after surgery it decreased to 1.4±0.5 points ($p<0.05$). According to DASH scale, the function of the of shoulder joint before surgery was 77,6±6,9 points, 6 months after surgery it increased to 12±5,2 points ($p<0.05$). According to BMRC scale (M0–M5), strength of the deltoid muscle before surgery was 2±0,4 points, after surgery it increased to 4,4±0,5 points ($p<0.05$). Range of motion in the shoulder joint before surgery was as follows: flexion 107±45,6°, extension 102±49°, external rotation 22±13,6°; 6 months after surgery: flexion 154±25,6°, extension 156±22,4°, external rotation 50±8° ($p<0,05$). The thickness of the middle portion of the deltoid muscle according to ultrasound examination before the surgery was 7.2±1.04 mm, after surgery 11.8±1.44 mm ($p<0.05$). All the patients (100%) during long follow-up noticed complete relief of pain and regression of neurological symptoms.

CONCLUSION The achieved results allow us to characterize the method of endoscopic transcapsular decompression as a reproducible, minimally invasive and highly effective technique providing pain relief to patients, curing neurological and intraarticular pathology, thus promoting early restoration of the upper limb function in the treated group of patients.

Keywords: axillary nerve, endoscopic decompression, neuropathy, neuropathic pain syndrome, shoulder arthroscopy
For citation Belyak EA, Asratyan SA, Lazko MF, Lazko FL, Paskhin DL, Prizov AP, et al. Experience of Endoscopic Transcapsular Axillary Nerve Decompression. *Russian Sklifosovsky Journal of Emergency Medical Care*. 2023;12(2):282–290. https://doi.org/10.23934/2223-9022-2023-12-2-282-290 (in Russ.)
Conflict of interest Authors declare lack of the conflicts of interests
Acknowledgments, sponsorship The study has no sponsorship

Affiliations

Evgeny A. Belyak	Candidate of Medical Sciences, Traumatologist-Orthopedist, Department of Traumatology and Orthopedics, V.M. Buyanov Moscow City Clinical Hospital; Associate Professor, Department of Traumatology and Orthopedics, Medical Institute, Peoples' Friendship University of Russia; https://orcid.org/0000-0002-2542-8308, belyakevgen@mail.ru; 40%, concept and design of the study, collection and processing of material, statistical processing, text writing
Sarkis A. Asratyan	Candidate of Medical Sciences, Neurosurgeon, Deputy Chief Physician for Surgery, V.M. Buyanov Moscow City Clinical Hospital; https://orcid.org/0000-0001-8472-4249, dr.sako@mail.ru; 10%, text editing
Maxim F. Lazko	Traumatologist-Orthopedist, Department of Traumatology and Orthopedics, V.M. Buyanov Moscow City Clinical Hospital; Assistant, Medical Institute, Peoples' Friendship University of Russia; https://orcid.org/0000-0001-6346-824X, maxim_lazko@mail.ru; 10%, research concept and design, text writing, editing

Fedor L. Lazko	Doctor of Medical Sciences, Traumatologist-Orthopedist, Department of Traumatology and Orthopedics, V.M. Buyanov Moscow City Clinical Hospital; Professor, Department of Traumatology and Orthopedics, Medical Institute, Peoples' Friendship University of Russia; https://orcid.org/0000-0001-5292-7930, fedor_lazko@mail.ru; 10%, study concept and design
Dmitry L. Paskhin	Neurosurgeon, Department of Neurosurgery, V.M. Buyanov Moscow City Clinical Hospital; https://orcid.org/0000-0003-3915-7796, yas-moe@mail.ru; 10%, concept and design of the study, collection and processing of material, text writing
Alexey P. Prizov	Candidate of Medical Sciences, Traumatologist-Orthopedist, Department of Traumatology and Orthopedics, V.M. Buyanov Moscow City Clinical Hospital; Associate Professor, Department of Traumatology and Orthopedics, Medical Institute, Peoples' Friendship University of Russia; https://orcid.org/0000-0003-3092-9753, aprizov@yandex.ru; 10%, statistical processing
Daniil S. Smirnov	Candidate of Medical Sciences, Neurosurgeon, Department of Neurosurgery, V.M. Buyanov Moscow City Clinical Hospital; https://orcid.org/0000-0002-2433-4027, dan.smirnov@mail.ru; 10%, collection and processing of material

BMRC - British Medical Research Council
DASH - Disability of arm, shoulder and hand
ENMG – electroneuromyography
RC - rotator cuff
VAS - visual analogue scale

INTRODUCTION AND RELEVANCE OF THE PROBLEM

Peripheral nerve injuries are a common and urgent problem in modern medicine [1]. Posttraumatic axillary nerve neuropathy most often occurs after humeral head dislocation (from 5 to 54% of cases) [2]. In some cases, axillary nerve injuries are possible when performing traumatological and orthopedic surgeries: the Latarjet technique for shoulder stabilization (up to 1.8% of cases), osteosynthesis for proximal humerus fractures, shoulder joint replacement (up to 1% of cases) and other operations [3–5]. Currently, due to the growth of household, industrial and transport injuries, development of extreme sports, there is an increase in the number of injuries of peripheral nerves, including the axillary one [6]. Clinically, damage to the axillary nerve is manifested by weakness and hypotrophy of the deltoid muscle, impaired sensitivity with the development of a persistent pain syndrome. Due to the complex anatomy of the shoulder, axillary nerve injuries are often combined with trauma to the structures of the shoulder joint: glenoid labrum, rotator cuff (RC), humeroscapular ligaments, the long head of the biceps brachii (LHB) tendon [7]. The treatment for axillary nerve neuropathy begins with conservative methods: exercise therapy, physiotherapy, vitamin therapy, anticholinesterase drugs, etc. Conservative therapy, as a rule, gives a good clinical effect and restoration of nerve function, however, in 10–15% of cases, surgery has to be resorted to [8].

The standard intervention for post-traumatic neuropathy of the axillary nerve is decompression from an extended skin incision (10–15 cm) with traction of large muscle groups. With the development of endoscopic techniques, the question arose about the possibility of performing endoscopic decompression, its advantages over open surgery, clarification of indications and comparison of treatment outcomes. Thus, according to the conducted meta-analyses, the endoscopic technique is not inferior in efficiency to open decompression, and at the same time allows surgeons to reduce the duration of disability, improve cosmetic results, reduce the amount of analgesics in the postoperative period, and examine the nerve trunk over a longer area. Minimally invasive endoscopic access has a number of advantages compared to open surgery: less tissue trauma, better cosmetic effect, low risk of recurrence, and the possibility of simultaneous correction of intraarticular pathology. Therefore, the features of the axillary nerve anatomy, the complexity of surgical access to the middle third of the nerve trunk, the frequent combination of neuropathy with intraarticular pathology indicated the high relevance of our study and the development of the combined endoscopic surgical technique.

Aim of the study: to improve the results of surgical treatment of patients with posttraumatic axillary neuropathy.

MATERIAL AND METHODS

Our study included 5 patients with posttraumatic axillary nerve neuropathy, who underwent surgery on the basis of the V.M. Buyanov Moscow City Clinical Hospital from 2018 to 2021. In all cases of observation, neuropathy was combined with intraarticular pathology. Before surgery, conventional conservative therapy was carried out for at least 3 months, which included electromyostimulation, exercise therapy, physiotherapy, vitamin therapy, and anticholinesterase drugs intake. In all the cases, there was no effect of conservative treatment.

The decision on the issue of surgical intervention was made by a council of traumatologist-orthopedist and neurosurgeon at the V.M. Buyanov Moscow City Clinical Hospital. Clinical examination included assessment of neurological and orthopedic status. Pain intensity was assessed using the visual analog scale (VAS) scale; shoulder joint function – the Disability of the Arm, Shoulder and Hand (DASH) function score; deltoid weakness - the British Medical Research Council (BMRC) scale (M0–M5). The amplitude of movements in the shoulder joint was also measured [9–11]. For additional examination, radiography of the shoulder joint in two projections, magnetic resonance imaging of the shoulder joint, ultrasound examination of the axillary nerve, and stimulation electroneuromyography (ENMG) of the nerves of the upper limb were performed.

The above volume of clinical and instrumental examination made it possible to determine the degree and level of damage to the axillary nerve, to identify concomitant intraarticular pathology. In all the cases, the anatomical integrity of the axillary nerve with signs of its compression in the area of the articular process of the scapula was confirmed. To assess the degree of hypotrophy of the deltoid muscle, ultrasound with the measurement of muscle thickness in the region of the middle bundle was performed. To do this, the ultrasonic sensor was placed longitudinally to the fibers of the deltoid muscle in the middle of the lateral edge of the acromial process of the scapula, and the thickness of the muscle was measured at a distance of 3 cm from the outer edge of the acromion process of the scapula.

CHARACTERISTICS OF CLINICAL MATERIAL

Our study included 5 men with posttraumatic axillary neuropathy. The mean age of the patients was 44.4±14.9 years. According to the VAS assessments, the intensity of the pain syndrome before surgery averaged 7±1 cm. According to the DASH score, the function of the shoulder joint before surgery was 77.6±6.9 points. According to the BMRC scale (M0–M5), the strength of the deltoid muscle before surgery was 2±0.4 points. The range of motion in the shoulder joint before surgery was as follows: flexion, 107±45.6°; extension, 102±49°; external rotation 10±9.6°. The thickness of the middle bundle of the deltoid muscle according to ultrasound data before surgery averaged 7±0.8 mm, 6 months after surgery — 10.6±1.1 mm ($p<0.05$). The patient age, the etiology of damage, as well as concomitant articular pathology are presented in Table 1.

Table 1

General characteristics of patients, concomitant joint pathology, and type of surgical procedure

Patient	Etiology of neuropathy	Period of conservative treatment, months	Concomitant intraarticular pathology (MRI + diagnostic arthroscopy)	Content of surgery
1. Ch.A., 38 years old	Humeral head dislocation	3	Tenosynovitis of the biceps tendon, degenerative changes of the glenoid labrum	Nerve decompression, biceps tenotomy, labrum debridement
2. T.D., 34 years old	the Latarjet procedure	6	Degenerative changes of the glenoid labrum, chondromalacia of the glenoid and humeral head	Nerve decompression, labrum debridement, debridement of areas of chondromalacia of the glenoid and humeral head
3. M.V., 74 years old	Humeral head dislocation	3	Massive RC tears, tenosynovitis of the biceps tendon, degenerative changes of the glenoid labrum	Nerve decompression, biceps tenotomy, labrum debridement, subacromial spacer placement
4. P.I., 24 years old	Habitual dislocation of the humeral head	6	Avulsion of anterior glenoid labrum	Nerve decompression, anterior glenoid labrum refixation
5. T.D., 52 years old	Humeral head dislocation	3	RC tendon avulsion, degenerative changes of the glenoid labrum	Nerve decompression, RC suture, labrum debridement,

Note: RC – rotator cuff; MRI - magnetic resonance imaging

SURGICAL TECHNIQUE

The technique of combined endoscopic intervention implies simultaneous orthopedic (shoulder joint arthroscopy) and neurosurgical (endoscopic nerve decompression) components. The surgery was performed with the patient in the beach-chair position under general anesthesia (endotracheal anesthesia) (Fig. 1).

Standard 30° arthroscopes and equipment for arthroscopy of large joints were used (Fig. 2).

Fig. 1. Beach-chair position for performing shoulder arthroscopy and endoscopic transcapsular axillary nerve decompression

Fig. 2. Set of instruments for shoulder arthroscopy and endoscopic nerve decompression

Access to the joint cavity began with the installation of a standard posterior portal placement in the "soft spot" area [12]. Diagnostic arthroscopy of the shoulder joint was performed with assessment of intraarticular structures (Fig. 3).

After the diagnostic stage of arthroscopy, the therapeutic stage for intraarticular pathology was carried out. This included tenotomy in cases of tenosynovitis and long head of the biceps tendon trauma (Fig. 4), restoration of the RC in case of injury, debridement in case of degenerative changes of the glenoid labrum, debridement and abrasion chondroplasty with a shaver and ablator in case of chondromalacia of the humeral head and (or) articular process of the scapula.

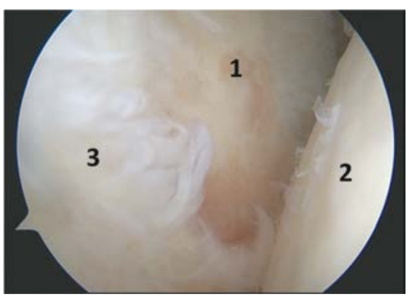

Fig. 3. Endoscopic view of the shoulder joint. 1 – Glenoid. 2 — Humeral head. 3 – Degenerated posterior labrum

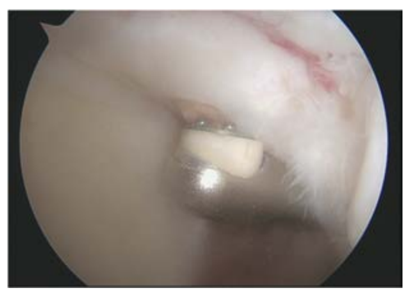

Fig. 4. Performing long head of biceps tenotomy

In one case, a massive nonrepairable rupture of the tendon of the rotator cuff was revealed, in this connection a subacromial spacer was implanted [13] (Fig. 5).

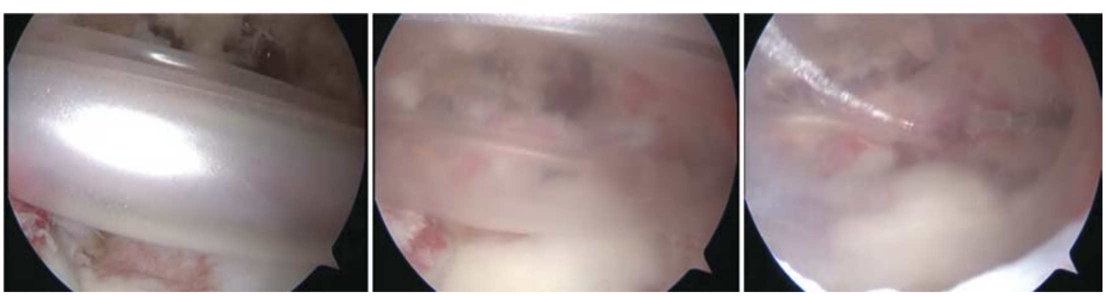

Fig. 5. Stages of subacromial spacer implantation in case of massive rotator cuff rupture

After arthroscopic sanitation of the joint cavity, we proceeded to perform access to the axillary nerve. The arthroscope was transferred to the region of the lower pocket of the shoulder joint. An additional posterior external approach was performed under the control of a spinal needle (Fig. 6).

A working portal was formed along the direction of the needle; a working instrument was inserted into it (Fig. 7).

Access to the axillary nerve was carried out by dissecting the inferior capsule with sequential separation of scar tissues (Fig. 8).

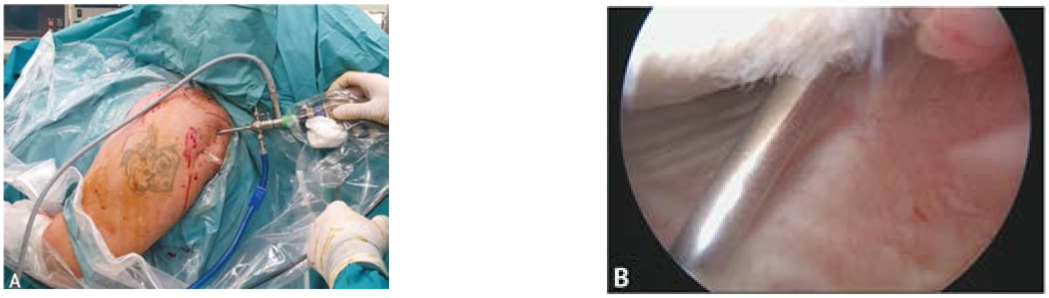

Fig. 6. A — Spinal needle insertion in projection of posterolateral portal. B — Visualization of the needle tip in the joint

Fig. 7. Position of the arthroscope and the working instrument during nerve decompression

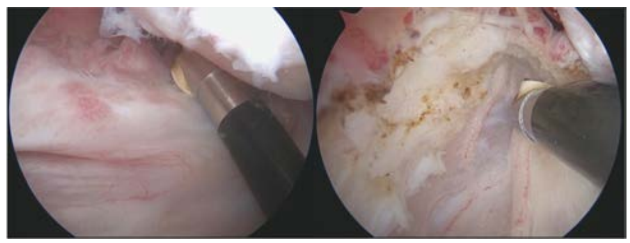

Fig. 8. Inferior capsulotomy and axillary nerve approach

In all the cases, compression of the axillary nerve by coarse scar tissue was detected. In order to decompress it, external decompression was performed in this area (Fig. 9).

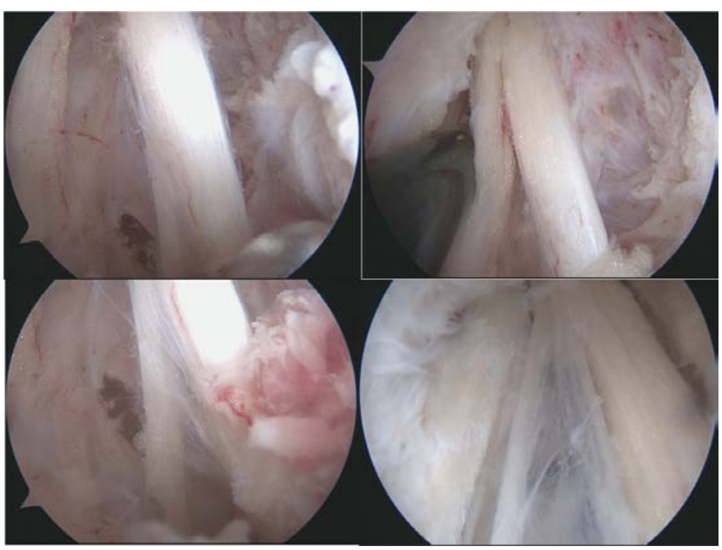

Fig. 9. Axillary nerve and its branches after decompression

In the postoperative period, dressings, analgesic, antiplatelet, metabolic, vascular, neurotropic and vitamin therapy were performed. Movement in the joint was allowed the next day after surgery. Electromyostimulation was resumed immediately after surgery. Courses of exercise therapy and physiotherapy began, as a rule, 2 weeks after the healing of postoperative wounds. In all the patients, the wounds healed by primary intention, the sutures were removed on average on the 10th day. In the case of RC suture and glenoid labrum refixation (patients No. 4 and No. 5), immobilization in a kerchief orthosis was indicated for 4 weeks. There were no complications in the early and late postoperative periods.

OUTCOMES

The follow-up clinical examination of the patients was carried out 3 and 6 months after surgery. A control ultrasound of the deltoid muscle was performed. ENMG stimulation was performed 6 months after surgery.

At the control examination after 3 months, the patients noted a decrease in pain, an increase in the range of motion in the shoulder joint, and regression of neurological disorders. VAS pain score was 2.8±1.04 cm. DASH score was 28.6±8.9 points. According to BMRC scale (M0–M5), the strength of the deltoid muscle increased to grade 3.2±0.64. The range of motion in the shoulder joint increased and amounted to: flexion 143±31.4°, extension 143±30.4°, external rotation 38±8.4°. The thickness of the medial bundle of the deltoid muscle, according to ultrasound data, increased to 8.8±0.96 mm.

At the control examination after 6 months, all the patients noted a significant decrease in pain in the shoulder joint, restoration of its function. Clinically, there was an increase in the range of motion in the shoulder joint, an increase in the volume of the deltoid muscle, and restoration of sensitivity in the deltoid region. VAS pain score was 1±0.4 cm ($p<0.05$). DASH score was 28.6±8.9 points ($p<0.05$). According to the BMRC scale (M0–M5), the strength of the deltoid muscle increased to 4.6±0.48 points ($p<0.05$). The range of motion in the shoulder joint increased and amounted to: flexion 154±25.6°, extension 156±22.4°, external rotation 50±8° ($p<0.05$). The thickness of the medial bundle of the deltoid muscle, according to ultrasound data, increased to 10.6±1.12 mm ($p<0.05$). During ENMG stimulation, positive dynamics was noted in the form of an increase in the amplitude of the M-response.

Table 2 shows the dynamics of changes in the above parameters with assessment of statistical significance.

Table 2

Changes in the studied parameters after surgery

Parameters	Before surgery	3 months after surgery	6 months after surgery	Significance level, p
Pain syndrome (VAS)	7	2,8	1	$p_1<0,05$ $p_2<0,05$ $p_3<0,05$
Upper limb dysfunction (DASH)	77.6	28.6	12	$p_1<0,05$ $p_2<0,05$ $p_3<0,05$
Deltoid Strength (BMRC)	2	3.2	4.6	$p_1<0,05$ $p_2<0,05$ $p_3<0,05$
Flexion	107	143	154	$p_1=0,07$ $p_2<0,05$ $p_3<0,05$
Extension	102	143	156	$p_1<0,05$ $p_2=0,1$ $p_3<0,05$
External rotation	22	38	50	$p_1<0,05$ $p_2<0,05$ $p_3<0,05$
Deltoid thickness	7	8.8	10.6	$p_1<0,05$ $p_2<0,05$ $p_3<0,05$

Notes: p_1 is the significance level of parameter change from the moment of surgery to 3 months after surgery; p_2 is the significance level of parameter change from 3 to 6 months after surgery; p_3 is the significance level of parameter change from the moment of surgery to 6 months after surgery

Changes in the parameters (pain syndrome, degree of dysfunction, strength and thickness of the deltoid muscle) after surgery are shown in Fig. 10.

The change in the range of motion in the shoulder joint is shown in Figure 11.

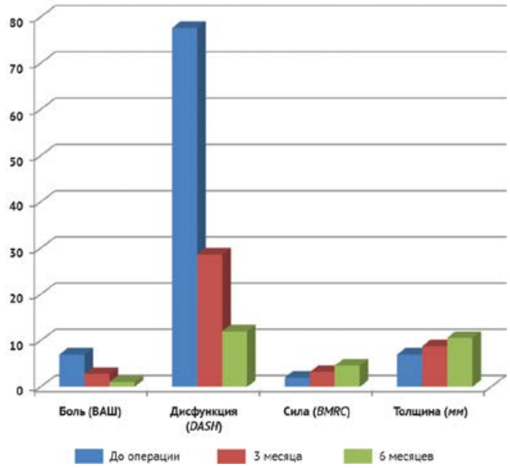

Fig. 10. Changes in the studied parameters after surgery

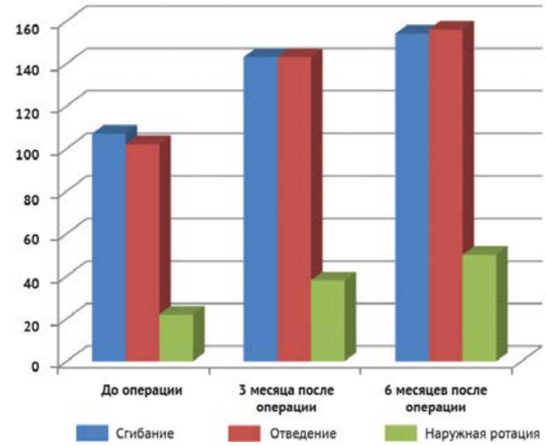

Fig. 11. Increased range of motion in the shoulder joint after surgery

A clinical outcome after surgery is shown in Figure 12 - there is a restoration of the volume and contour of the deltoid muscle 6 months after surgery.

Fig. 12. Restoration of volume and contour of the deltoid muscle after surgery.
A — Before surgery, B — 6 months after surgery

DISCUSSION

The release of the nerve trunk from the scar tissue while maintaining its anatomical integrity is an effective and long-established surgery. Thus, according to the literature, after open axillary nerve decompression, 92% of the treated patients noted an improvement [14–18]. Nerve decompression leads to the restoration of the conduction of the electrical impulse along the axons, and blood supply improves.

The incidence of postoperative complications in the endoscopic intervention group is lower compared to the open approach one. Thus, according to H.S. Vasiliadis et al., the complication rate for open decompression is 122 cases per 1000 surgeries versus 76 cases per 1000 surgeries for endoscopic intervention [19–21]. Studies on endoscopic nerve decompression (sciatic, axillary, peroneal, tibial and other nerves), unfortunately, are limited to small series or individual clinical cases. Arthroscopic transcapsular axillary nerve decompression was first described by P.J. Millett et al. in 2011. The authors performed 9 surgeries for chronic pain in the shoulder. After the intervention, the pain syndrome decreased in all the cases (100%) [22]. Endoscopy of the axillary nerve became a logical continuation of the development of arthroscopic paraarticular surgery of the shoulder joint, which was transformed into the concept of the *Comprehensive Arthroscopic Management Procedure* [23–26].

All the patients (100%) in our study after axillary nerve decompression showed an increase in muscle strength and regression of sensory disorders. There were no postoperative complications in our observation. It is possible that a good clinical outcomes in all the patients and the absence of postoperative complications, among other things, is associated with a small number of cases and a careful approach to patient selection.

In the domestic literature, there have been no reports of a series of clinical observations after endoscopic axillary nerve decompression. In this study, the surgical technique showed its effectiveness and safety, the possibility of simultaneous treatment of the pathology of the shoulder joint. The study is limited to a small series of observations, therefore, further research on a larger group of patients is required.

CONCLUSION

The technique of endoscopic transcapsular axillary nerve decompression in combination with arthroscopy of the shoulder joint in our study showed good results in the treatment of patients with axillary nerve pathology and concomitant intraarticular pathology.

On the one hand, endoscopic axillary nerve decompression has a number of undeniable advantages compared to open surgery - a significantly better cosmetic effect, less traumatization of soft tissues, and rapid postoperative recovery; on the other hand, this technique allows simultaneous sanitation of the shoulder joint cavity.

All components of the procedure were performed using standard arthroscopic equipment. The obtained primary data allow us to recommend the developed method for further research and application in practice to orthopedic traumatologists and neurosurgeons.

REFERENCES

1. Sharp E, Roberts M, Żurada-Zielińska A, Zurada A, Gielecki J, Tubbs RS, Loukas M. The most commonly injured nerves at surgery: A comprehensive review. *Clin Anat*. 2021;34(2):244–262. PMID: 33090551 https://doi.org/10.1002/ca.23696
2. Avis D, Power D. Axillary nerve injury associated with glenohumeral dislocation: A review and algorithm for management. *EFORT Open Rev*. 2018;3(3):70–77. PMID: 29657847 https://doi.org/10.1302/2058-5241.3.170003
3. Griesser MJ, Harris JD, McCoy BW, Hussain WM, Jones MH, Bishop JY, et al. Complications and re-operations after Bristow-Latarjet shoulder stabilization: a systematic review. *J Shoulder Elbow Surg*. 2013;22(2):286–292. PMID: 23352473 https://doi.org/ 10.1016/j.jse.2012.09.009
4. Bohsali KI, Wirth MA, Rockwood CA Jr. Complications of total shoulder arthroplasty. *J Bone Joint Surg Am*. 2006;88(10):2279–2292. PMID: 17015609 https://doi.org/10.2106/JBJS.F.00125
5. Patel MS, Wilent WB, Gutman MJ, Abboud JA. Incidence of peripheral nerve injury in revision total shoulder arthroplasty: an intraoperative nerve monitoring study. *J Shoulder Elbow Surg*. 2021;30(7):1603–1612. PMID: 33096272 https://doi.org/ 10.1016/j.jse.2020.09.024
6. Doi K, Muramatsu K, Hattori Y, Otsuka K, Tan SH, Nanda V, et al. Restoration of prehension with the double free muscle technique following complete avulsion of the brachial plexus. Indications and longterm results. *J Bone Joint Surg Am*. 2000;82(5):652–666. PMID: 10819276
7. Skedros JG, Henrie TR, Peterson MD. Rotator cuff tear following long-standing axillary neuropathy in a female motocross racer. *BMJ Case Rep*. 2018;2018:bcr2017223692. PMID: 29909385 https://doi.org/10.1136/bcr-2017-223692
8. Kugurakova GM, Volkova KM, Ablizen SI. Opyt lecheniya bol'nykh neyropatiey litsevogo nerva v usloviyakh otdeleniya vosstanovitel'nogo lecheniya. *Zdravookhranenie Chuvashii*. 2013;(1):61–64. (In Russ.)
9. Roy JS, MacDermid JC, Woodhouse LJ. Measuring shoulder function: a systematic review of four questionnaires. *Arthritis Rheum*. 2009;61(5):623–632. PMID: 19405008 https://doi.org/10.1002/art.24396
10. *Aids to the examination of the peripheral nervous system*. 4-th edition. London: Elsevier Saunders; 2000.
11. Reed MD, Van Nostran W. Assessing pain intensity with the visual analog scale: a plea for uniformity. *J Clin Pharmacol*. 2014;54(3):241–234. https://doi.org/10.1002/jcph.250 PMID: 24374753
12. Erçakmak B, Günenç Beşer C, Özsoy MH, Demiryürek MD, Bayramoğlu A, Hayran KM. Soft spot: the important zone at the standard posterior portal of shoulder arthroscopy. *Turk J Med Sci*. 2018;48(1):89–92. PMID: 29479963 https://doi.org/10.3906/sag-1708-54
13. Lazko MF, Maglaperidze IG, Lazko FL, Prizov AP, Belyak EA. Effektivnost' primeneniya subakromial'nogo ballona INSPACE v lechenii patsientov s bol'shimi i massivnymi povrezhdeniyami vrashchatel'noy manzhety plecha. *Georgian Medical News*. 2021;315(6):33–39. (In Russ.)
14. Lee S, Saetia K, Saha S, Kline DG, Kim DH. Axillary nerve injury associated with sports. *Neurosurg Focus*. 2011;31(5):E10. PMID: 22044099 https://doi.org/10.3171/2011.8.FOCUS11183
15. Kline DG, Kim DH. Axillary nerve repair in 99 patients with 101 stretch injuries. *J Neurosurg*. 2003;99(4):630–636. PMID: 14567596 https://doi.org/10.3171/jns.2003.99.4.0630
16. Gutkowska O, Martynkiewicz J, Mizia S, Bąk M, Gosk J. Results of Operative Treatment of Brachial Plexus Injury Resulting from Shoulder Dislocation: A Study with A Long-Term Follow-Up. *World Neurosurg*. 2017;105:623–631. PMID: 28624567 https://doi.org/10.1016/j.wneu.2017.06.059
17. Guerra WK, Baldauf J, Schroeder HW. Long-term results after microsurgical repair of traumatic nerve lesions of the upper extremities. *Zentralbl Neurochir*. 2007;68(4):195–199. PMID: 17968781 https://doi.org/10.1055/s-2007-985859
18. Chen WA, Schippert DW, Daws SB, Koman LA, Li Z. Surgical Algorithm and Results of Isolated Traumatic Axillary Nerve Injuries. *J Reconstr Microsurg*. 2016;32(3):208–14. PMID: 26473794 https://doi.org/10.1055/s-0035-1565250
19. Buchanan PJ, Chieng LO, Hubbard ZS, Law TY, Chim H. Endoscopic versus Open in Situ Cubital Tunnel Release: A Systematic Review of the Literature and Meta-Analysis of 655 Patients. *Plast Reconstr Surg*. 2018;141(3):679–684. PMID: 29481399 https://doi.org/10.1097/PRS.0000000000004112

20. Vasiliadis HS, Nikolakopoulou A, Shrier I, Lunn MP, Brassington R, Scholten RJ, et al. Endoscopic and Open Release Similarly Safe for the Treatment of Carpal Tunnel Syndrome. A Systematic Review and Meta-Analysis. *PLoS One*. 2015;10(12):e0143683. PMID: 26674211 https://doi.org/10.1371/journal.pone.0143683
21. Aldekhayel S, Govshievich A, Lee J, Tahiri Y, Luc M. Endoscopic Versus Open Cubital Tunnel Release: A Systematic Review and Meta-Analysis. *Hand (N Y)*. 2016;11(1):36-44. PMID: 27418887 https://doi.org/10.1177/1558944715616097
22. Millett PJ, Gaskill TR. Arthroscopic trans-capsular axillary nerve decompression: indication and surgical technique. *Arthroscopy*. 2011;27(10):1444–1448. PMID: 21831569 https://doi.org/10.1016/j.arthro.2011.05.003
23. Borrel F, Desmoineaux P, Delcourt T, Pujol N. Feasibility of arthroscopic decompression of the axillary nerve in the quadrilateral space: Cadaver study. *Orthop Traumatol Surg Res*. 2021;107(1):102762. PMID: 33333278 https://doi.org/10.1016/j.otsr.2020.102762
24. Mook WR, Petri M, Greenspoon JA, Millett PJ. The Comprehensive Arthroscopic Management Procedure for Treatment of Glenohumeral Osteoarthritis. *Arthrosc Tech.* 2015;4(5):e435–441. PMID: 26697301 https://doi.org/10.1016/j.eats.2015.04.003
25. Millett PJ, Horan MP, Pennock AT, Rios D. Comprehensive Arthroscopic Management (CAM) procedure: clinical results of a joint-preserving arthroscopic treatment for young, active patients with advanced shoulder osteoarthritis. *Arthroscopy*. 2013;29(3):440–448. PMID: 23544687 https://doi.org/10.1016/j.arthro.2012.10.028
26. Tao MA, Karas V, Riboh JC, Laver L, Garrigues GE. Management of the Stiff Shoulder with Arthroscopic Circumferential Capsulotomy and Axillary Nerve Release. *Arthrosc Tech*. 2017;6(2):e319–e324. PMID: 28580248 https://doi.org/10.1016/j.eats.2016.10.005

Received on 06.03.2022

Review completed on 22.03.2023

Accepted on 28.03.2023