

Extra-Articular Endoscopic BP Decompression—Surgical Technique



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Abstract: We describe all-endoscopic brachial plexus (BP) decompression. Surgery is performed with the patient in the beach-chair position with the usual arthroscopic instruments and pump. The first step is to create 2 portals at the area of the coracoid process and decompress the infraclavicular part of the BP at area of thoracic aperture and coracoid. The second step includes performing 2 portals at supraclavicular fossa and performing decompression of BP at interscalene space. The postoperative period includes a short period of sling immobilization (3-5 days), immediate passive motion after surgery, and active motion after removal of the sling.

Endoscopic surgery of peripheral nerves is a highly developed direction in both neurosurgery and orthopedics. Brachial plexus (BP) endoscopic surgery is a pretty «young» part of this direction. There were published two endoscopic approaches how to get to the BP: one approach is from thoracic cavity which is made by thoracic endoscopic surgeons.^{1,2} The other approach is made from the shoulder joint and was developed and published by Lafosse et al.³ and Le Hanneur et al.^{3,4} All of these methods have one main disadvantage—the

surgeon has to intervene primary to a normal anatomical cavity, which is not damaged, and then go from this cavity in the direction of BP with or without first rib resection. This makes the procedure more prolonged and difficult, which traumatizes the shoulder joint and thoracic cavity, and can have some postoperative complications connected to the shoulder joint (synovitis, stiffness) and thoracic cavity (pneumothorax, hydrothorax, hyllothorax). In addition the neurosurgeon does not have skill and certification to perform shoulder arthroscopy and thoracic endoscopy. That is why the development of direct endoscopic access to the BP in both infraclavicular and supraclavicular parts is very acute and useful both for both orthopaedic surgeons and neurosurgeons. This technique solves these problems.

Surgical Technique

The main indications for extra-articular endoscopic brachial plexus decompression is post-traumatic BP plexopathy of Sunderland classification stage 1-4 with no anatomic rupture of the trunks and cords of the BP and failure of conservative treatment for 3 to 4 months (Table 1).⁵ During surgery the patient is in the beach-chair position under general anesthesia.

The first step of the surgery is palpation and marking of anatomic landmarks and endoscopic portals (Fig 1). After that we use a special «atraumatic» technique of creating portals. We make only skin incisions with a blade in projection of portals, and then with a straight mosquito clamp we bluntly make a channel in the

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direction to the tip of coracoid and palpate it by the tip of the mosquito clamp. Then we introduce a scope (4K 30° Scope, Karl Storz SE & Co. KG, Tuttlingen, Germany) into the anterolateral portal and instrument into the anteromedial portal and visualize the tip and superior part of the coracoid process (Fig 2).

During the approach to the coracoid process, we can visualize the tip of the mosquito clamp and the coracoclavicular ligaments (Fig 3). We use a standard arthroscopic pump (24K Pump; Conmed Linvatec, Largo, FL) and saline solution for the procedure. Then we perform a release at the area of the coracoid process and continue this release in a medial direction toward the pectoralis minor muscle. Next we detach the pectoralis minor muscle from the coracoid, and this is the first step for performing the endoscopic “window-approach” to brachial plexus (Fig 4).

Then we go up to the clavicle and make a release close to it, visualize the subclavian muscle, and detach the lateral portion of the subclavian muscle from the clavicle (Fig 4). This is the second step for creating an endoscopic “window-approach” to the brachial plexus. Then we remove fibrous, scar, and fat tissue through this “window” with the use of a shaver (Advantage Turbo/Console; Conmed Linvatec) and ablator (Quantum 2; Smith & Nephew, London, UK) to get an approach to the brachial plexus. Figure 5 shows a schematic view of the placement of scope and instrument during the approach to the plexus. Afterward we perform neurolysis by cutting and removing all adhesions and scar tissue between the cords and divisions of the brachial plexus (Fig 6).

After decompression of the infraclavicular part of the brachial plexus in the area of the thoracic aperture and coracoid process, we go to supraclavicular part. Under arthroscopic control with the help of needles for guiding, we create 2 supraclavicular portals in the supraclavicular fossa: one anterior and one posterior. Then we switch the scope into the posterior supraclavicular portal and instrument into the anterior supraclavicular portal. Figure 7 shows a schematic view of the instrument position during the approach to the supraclavicular part of the BP. We start the release and dissection in the supraclavicular area toward the interscalene space while the suprascapular nerve is a tracker for us—the dissection is performed along this

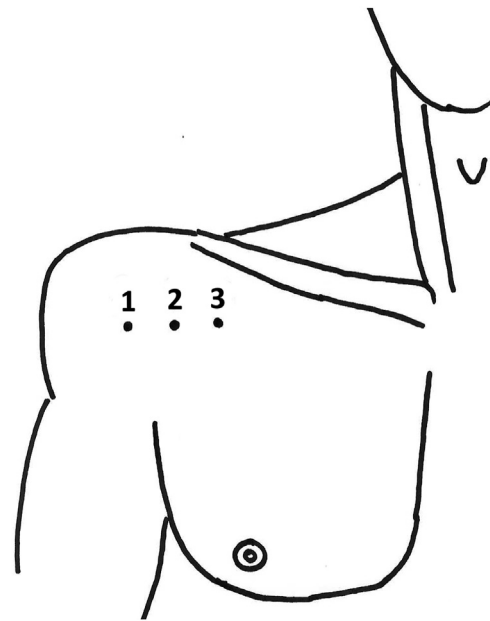


Fig 1. Anterior view of right shoulder area, beach-chair position of patient. Preoperative planning and projection of portals, where 1 = anterolateral portal, 2 = tip of the coracoid, and 3 = anteromedial portal. Distance 1-2 = 2-3 = 1.5-2 cm.

nerve proximally. The fat tissue is removed by a shaver, and the scar and adhesions are cut by an ablator.

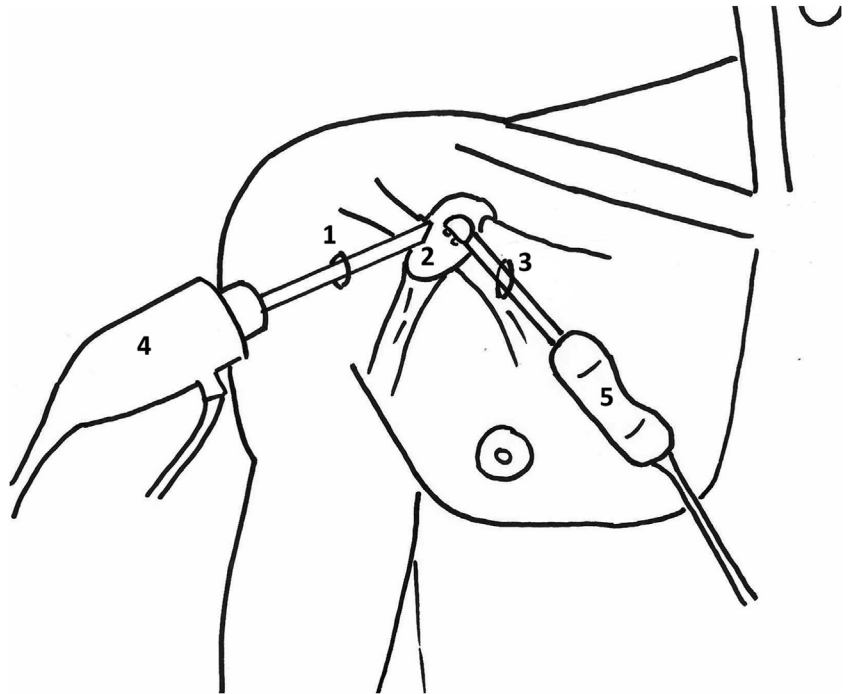
After dissection we visualize the superior, median, and inferior trunks of the BP and the median scalene muscle, and we cut the scars and adhesions between them by performing neurolysis and decompression (Fig 8). If needed, the surgeon can perform scalenotomy with an ablator. The following are danger zones: anteriorly to the BP passing the subclavian artery and between the median and inferior trunks passing from the front to the back branch of the subclavian artery—the dorsal scapular artery; damage to these vascular structures can lead to big problems (Fig 9).

There are also some small veins in this area, but they don't create large problems for surgeon because coagulation with an ablator is enough. The final step of the surgery is suturing the portals. There is always some swallowing of shoulder and neck areas after surgery, but it does not create any problems, and edema decreases the day after surgery with no consequences. Figure 10 shows a postoperative view of the portals

Table 1. Sunderland Classification of Peripheral Nerve Injury

Stage	Name of the Stage	Characteristics
1	Neuropraxia	Concussion of nerve. Focal conduction block. No Wallerian degeneration.
2	Axonotmesis 1	Axonal disruption, Wallerian degeneration of peripheral part. Nerve sheaths are intact.
3	Axonotmesis 2	Axonal disruption. Endoneurium disruption.
4	Axonotmesis 3	Axonal disruption. Endoneurium disruption. Perineurium disruption.
5	Neurotmesis	Axonal disruption. Endoneurium disruption. Perineurium disruption. Epineurium disruption.

Fig 2. Right shoulder area, beach-chair position of patient. Schematic view of placement of the arthroscope and instrument during the endoscopic approach to coracoid process area: 1 = anterolateral portal, 2 = tip of the coracoid, 3 = anteromedial portal, 4 = arthroscope, and 5 = working instrument (ablator).



and the surgical field. Surgical demonstration of endoscopic decompression of brachial plexus is performed on [Video 1](#).

Postoperative Period

We usually use sling immobilization for 3 to 5 days after surgery, but the patient starts passive motion in the shoulder joint and active motion in the elbow and wrist the day after surgery. At 10 days after surgery when the wounds are healing, the patient starts a

rehabilitation protocol with physiotherapy and active exercises.

Discussion

Endoscopic neurolysis of the BP using standard arthroscopic instruments has definite advantages over the open technique: minimally invasive; avoiding of detachment of the pectoralis major muscle; the possibility of complete visualization; revision of the neural

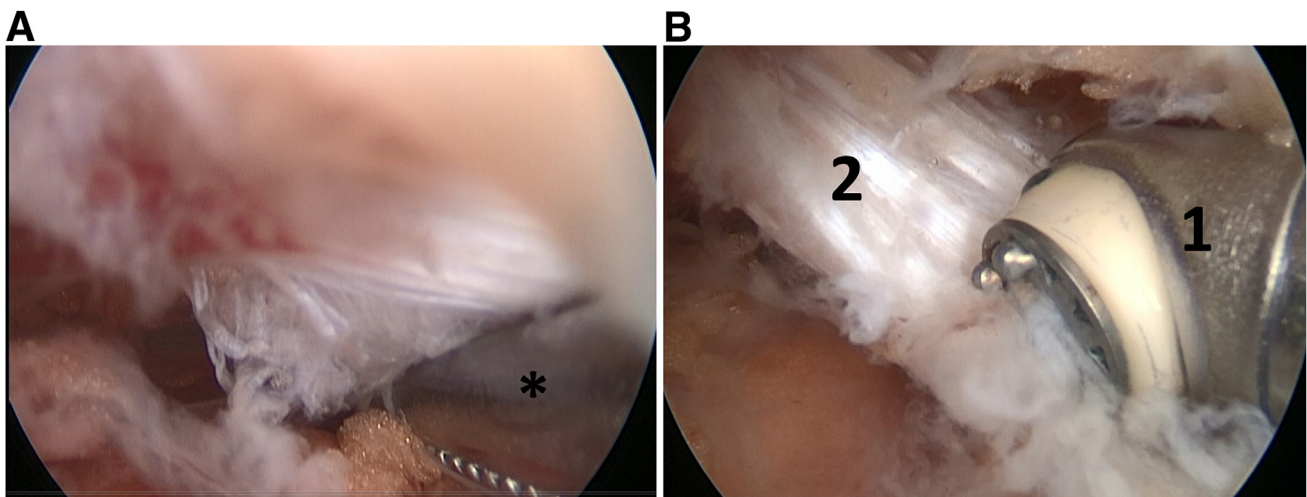


Fig 3. (A) Endoscopic approach to the coracoid process area. The scope is already introduced into the anterolateral portal, and the second portal is made with a mosquito clamp (*) under arthroscopic control. The patient is in the beach-chair position, and the procedure is performed in the right shoulder area. (B) Endoscopic approach to the coracoid process area and introducing instrument. The ablator (1) is already introduced, and the coracoclavicular ligament (2) is visualized. The patient is in the beach-chair position, and the procedure is performed in the right shoulder area.

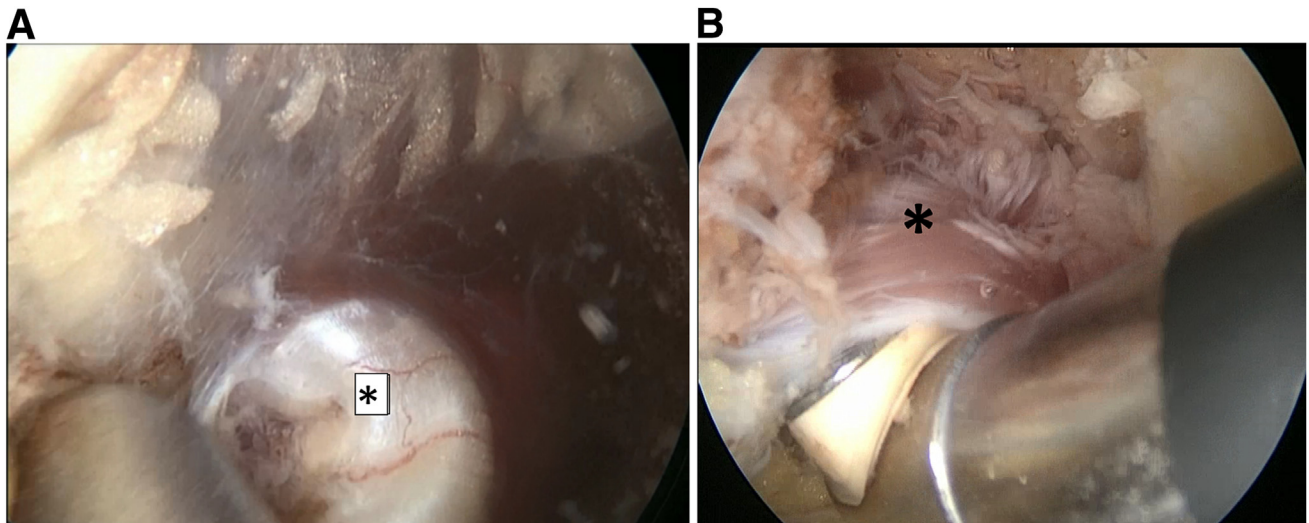


Fig 4. (A) First step of creating the “endoscopic window” to the brachial plexus: detachment of the pectoralis minor muscle (*) from the coracoid process. The scope is in the anterolateral portal, and the instrument is in the anteromedial portal. The patient is in the beach-chair position, and the procedure is performed in the right shoulder area. (B) Second step of creating the “endoscopic window” to brachial plexus: detachment of the lateral portion of the subclavian muscle (*) from the clavicle. The scope is in the anterolateral portal, and the instrument is in the anteromedial portal. The patient is in the beach-chair position, and the procedure is performed in the right shoulder area.

structures in the subclavian, retroclavicular, and supraclavicular spaces; good optical picture with zoom; and perfect cosmetic results.⁶ Endoscopic nerve suturing remains the main unsolved problem. In 2015 Lafosse et al.⁷ described a cadaver study and confirmed the possibility of arthroscopic BP decompression; afterward they performed the surgical technique in clinical practice. The first step of the surgery is performing the shoulder joint arthroscopy, and then capsulotomy and release of the rotator interval are

performed, along with further dissection at the area of the coracoid process and BP visualization.

Interference of the shoulder joint cavity and damage of the capsule is unjustified in cases of absence of shoulder joint pathology. Later the authors modified their technique for avoiding shoulder joint arthroscopy and capsular damaging, but posterior portal and subacromial space arthroscopy were still performed, and the surgery was complicated and used 8 to 10 endoscopic portals.³ Furushima and Funakoshi⁸ presented their technique

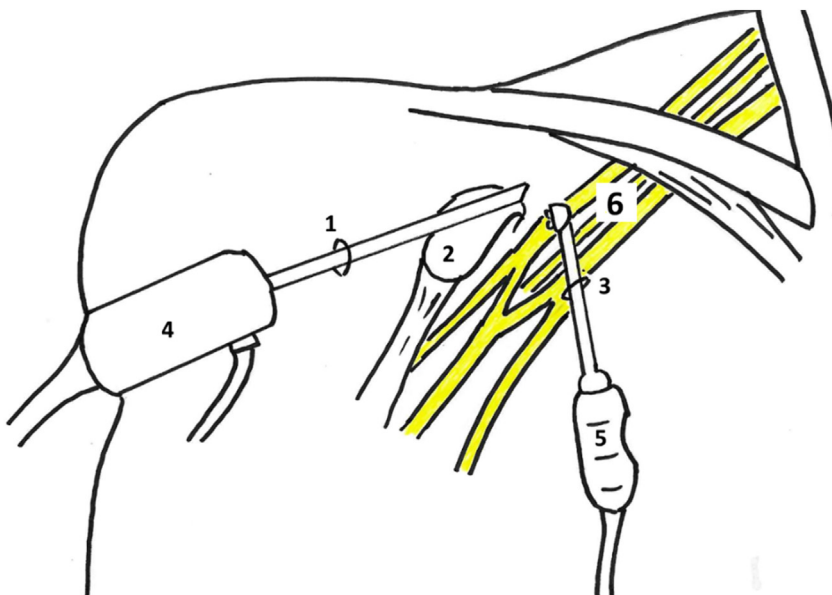


Fig 5. Topographic anatomy and schematic view of the approach to the infraclavicular part of the brachial plexus through the “endoscopic window,” where 1 = the anterolateral portal, 2 = the tip of the coracoid process, 3 = the anteromedial portal, 4 = the arthroscope, 5 = the working instrument (ablator), and 6 = brachial plexus. The patient is in the beach-chair position, and the procedure is performed in the right shoulder area.

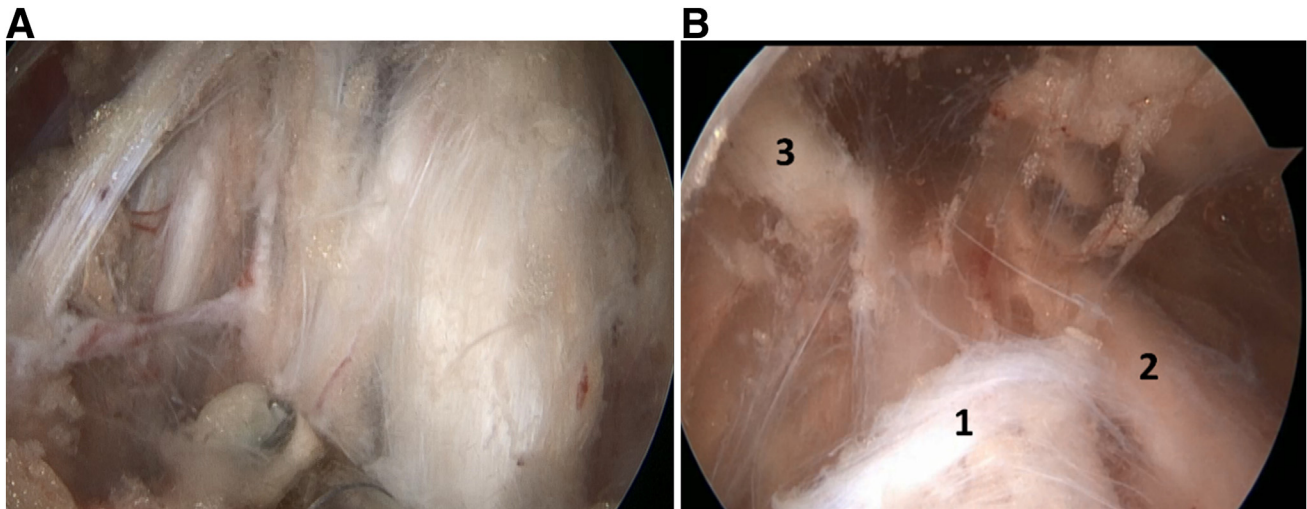


Fig 6. (A) Endoscopic view of the brachial plexus (BP) after decompression: numerous branches of the BP. The scope is in the anterolateral portal, and the instrument is in the anteromedial portal. The patient is in the beach-chair position, and the procedure is performed in the right shoulder area. (B) Endoscopic view of the BP after decompression: anterior (1) and posterior (2) division of the superior trunk of the BP and the suprascapular nerve (3). The scope is in the anterolateral portal, and the instrument is in the anteromedial portal. The patient is in the beach-chair position, and the procedure is performed in the right shoulder area.

of decompression BP in thoracic outlet syndrome and first rib resection, but it was a minimally invasive arthroscope-assisted technique through a small incision in the axillary fossa. In 2012 Garcia et al.⁹ proposed a technique for creating supraclavicular and infraclavicular portals in the middle of the clavicle and avoiding penetrating into shoulder joint. But the cadaveric study performed by Belyak et al.¹⁰ demonstrated that the middle

of the clavicle is a projection of the subclavian artery and vein and that creating portals in this area without endoscopic control can be dangerous.¹⁰

Our surgical technique as described is safe because placement of the portals is far from the neurovascular bundle, and the coracoid and acromial processes are good anatomic landmarks and limiters of instrument introduction. The main advantages of the technique

Fig 7. Schematic view of the topographic anatomy and the endoscopic approach to the supraclavicular part of the brachial plexus at the interscalene space, where 1 = the superior trunk of the brachial plexus, 2 = the median trunk, 3 = the inferior trunk, 4 = the subclavian artery, 5 = the supraclavicular nerve, 6 = the anterior scalene muscle, 7 = the median scalene muscle, 8 = the clavicle, 9 = the first rib, 10 = the anterior supraclavicular portal, 11 = the posterior supraclavicular portal, 12 = the working instrument (ablator), and 13 = the arthroscope. The scope is in the posterior supraclavicular portal, and the instrument is in the anterior supraclavicular portal. The patient is in the beach-chair position, and the procedure is performed in the right shoulder area.

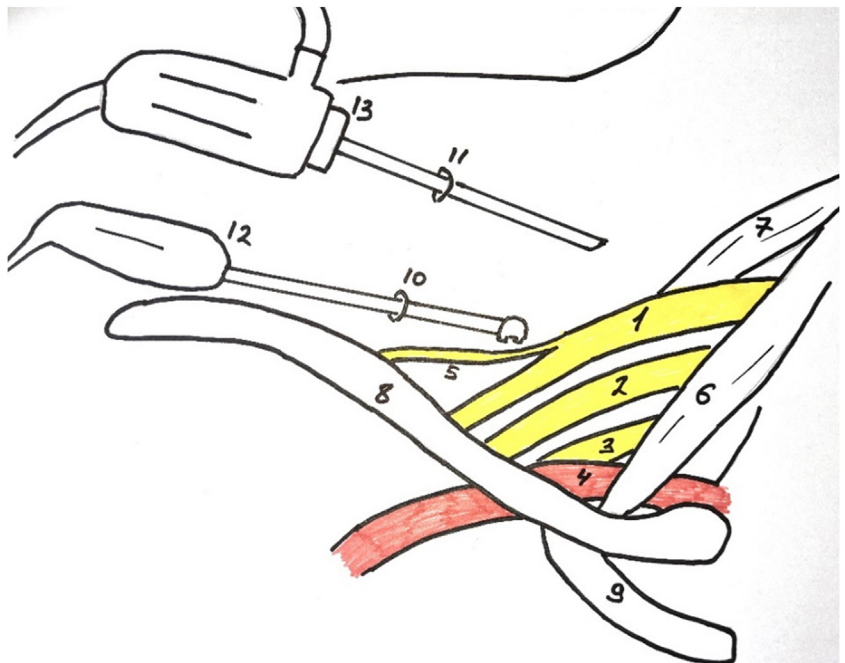




Fig 8. Components of the brachial plexus in the interscalene space after decompression, where 1 = the superior trunk, 2 = the median trunk, and 3 = the median scalene muscle. The scope is in the posterior supraclavicular portal, and the instrument is in the anterior supraclavicular portal. The patient is in the beach-chair position, and the procedure is performed in the right shoulder area.

include avoiding performing shoulder joint arthroscopy and the absence of capsular and rotator interval damage; the possibility of both orthopaedic surgeons and neurosurgeons performing the surgery; and using only 4 endoscopic portals for complete BP revision and decompression.

The surgical technique needs a standard arthroscopic set of instruments, which is in almost every arthroscopic operation room: a standard 30° scope, ablator,

shaver and more. The beach-chair position of the patient is well known and is comfortable for most surgeons. However, this technique has some risks and pitfalls; among them: the surgeon should take into account the deltopectoral sulcus to avoid damaging the cephalic vein; it is impossible to create first portals in the absence of the coracoid process (after bone-plasty procedures such as Latarjet). It is necessary to use controlled hypotension to decrease bleeding; the surgeon should know the topographic anatomy of the shoulder and neck areas to avoid damage to the nerve and vessels. Among limitations of the technique we can list: use of a saline environment and the arthroscopic pump limits the time of surgery—not more than 2 hours—otherwise edema will be too much, thus deteriorating the arthroscopic view and work of the surgeon, which can lead to compression syndrome and hyperperfusion. In addition, the surgeon should keep pressure in the pump as low as possible. Another limitation is the difficult approach and visualization of the medial cord and inferior trunk of the BP because our camera looks from lateral to medial. Pearls/pitfalls and advantages/disadvantages of the surgical technique are summarized in [Tables 2](#) and [3](#).

Conclusions

The developed technique allows us to perform all-endoscopic decompression and neurolysis of infraclavicular and supraclavicular parts of the BP without interfering with the shoulder joint cavity. Thus this technique is quicker and simpler and can be easily

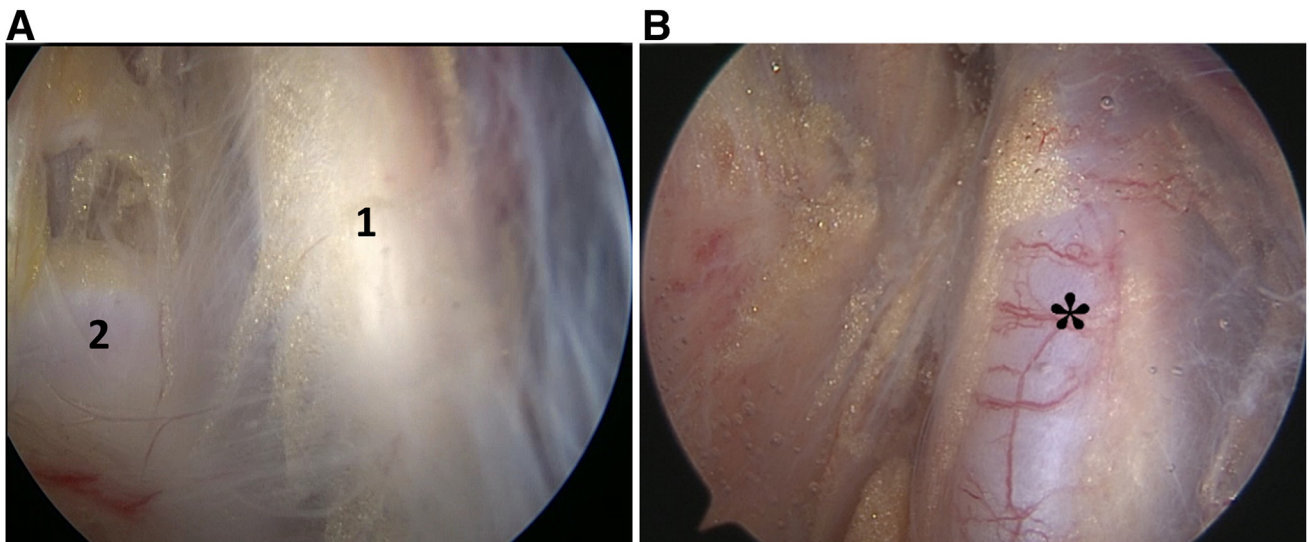


Fig 9. (A) Dangerous vascular structures: 1 = median trunk of the brachial plexus (BP), and 2 = arteria dorsalis scapulae. The scope is in the posterior supraclavicular portal. The patient is in the beach-chair position, and the procedure is performed in the right interscalene space. (B) Dangerous vascular structures: subclavian artery (*), which is anterior to the BP. The scope is in the posterior supraclavicular portal. The patient is in the beach-chair position, and the procedure is performed in the right interscalene space.



Fig 10. (A) Postoperative view of the right shoulder and neck areas and endoscopic portals. In the anterior view, we see 2 infraclavicular portals and 2 supraclavicular portals. (B) Postoperative view of the right shoulder and neck areas and endoscopic portals. In the posterior view, we see the absence of the posterior portal for shoulder joint arthroscopy because it was not performed.

Table 2. Pearls and Pitfalls of the Surgical Technique

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Pearls	
Avoiding of performing shoulder joint arthroscopy and absence of capsular and rotator interval damaging.	
Possibility of doing the surgery both by orthopaedic surgeons and neurosurgeons.	
Perfect cosmetic effect.	
Early and painless rehabilitation.	
Pitfalls	
Risk of damaging cephalic vein.	
Problems of performing first portals in case of absence of coracoid process (e.g., after a Latarjet procedure).	
Difficult approach and visualization of medial cord and inferior trunk of BP.	
Two dangerous arteries strongly connected to brachial plexus: subclavian artery (infraclavicular part of BP) and dorsal scapular artery (supraclavicular part of BP).	
BP, brachial plexus.	

performed by both orthopaedic surgeons and neurosurgeons.

Disclosures

The authors report no conflicts of interest in the authorship and publication of this article. Full ICMJE author disclosure forms are available for this article online, as [supplementary material](#).

Table 3. Advantages and Disadvantages of the Surgical Technique

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Advantages	
Using only 4 endoscopic portals for complete BP revision and decompression	
Surgery needs a standard arthroscopic set of instruments.	
Beach-chair position of patient is well-known and comfortable to work for most surgeons.	
No necessity of performing pectoralis major detachment or clavicular osteotomy/resection	
Disadvantages	
Necessity of using controlled hypotension to decrease bleeding.	
The surgeon should perfectly know the topographic anatomy of the shoulder and neck areas to avoid damaging nerves and vessels.	
Using of saline environment and arthroscopic pump limits the time of surgery—no more than 2 hours.	
Surgeon should keep pressure in the pump as low as possible.	
BP, brachial plexus.	

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