

METHODOLOGY IN ELBOW ARTHROSCOPY

Tsvetan Tsenkov ^(✉), Yassen Nikolov, Nikolay Dimitrov
University Hospital of Orthopaedics “Prof. Boicho Boichev”

Department of Orthopaedics and Traumatology, Medical University – Sofia, Sofia, Bulgaria
tsvetan.tsenkov@icloud.com

Abstract— At first arthroscopy was devised as a diagnostic tool, which then evolved in a therapeutically one with significant capabilities for the treatment of a wide specter of joint pathologies. The technique was first documented in 1912 when a Bruman (1932) explores the capabilities of arthroscope inserted into the elbow joint of human cadavers.

In the last 30 years the indications for performing elbow arthroscopy show significant development worldwide. The purpose of the initially described elbow arthroscopies was as a diagnostic tool, removal of loose bodies in the joint, synovectomy and adhesiolysis. The arthroscopy’s capacity for elbow joint pathology treatment have grown greatly with the accumulation of anatomical knowledge and experience in arthroscopic surgery. In recent years, excellent results are being reported for the arthroscopic treatment of lateral epicondylitis, osteochondritis dissecans, osteoarthritis and contractures.

Nonetheless, to perform an elbow arthroscopy requires high level of technical skillset. Accurate anatomical knowledge and sizeable arthroscopic experience is required. When taken into account the physiological peculiarity of the elbow region there is a risk of complications with relation to neuro-vascular injuries.

Premise for achieving good to excellent results with minimal percentage of complications are selecting a suitable patient, preoperative preparation, practiced team and adequate equipment. This article’s purpose is to present contemporary methodology for the performance of arthroscopic surgery of the elbow joint.

Keywords— arthroscopy, elbow joint, methodology

1. Introduction

At first arthroscopy was devised as a diagnostic tool, which then evolved in a therapeutically one with significant capabilities for the treatment of a wide specter of joint pathologies. The technique was first documented in 1912 when a Bruman (1932) explores the capabilities of arthroscope inserted into the elbow joint of human cadavers.

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arthroscopic surgery. In recent years, excellent results are being reported for the arthroscopic treatment of lateral epicondylitis, osteochondritis dissecans, osteoarthritis and contractures.

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2. Anesthesia

During elbow arthroscopic surgery a **regional** or **general** anesthesia can be used and each one has its positive and negative implications.

The regional anesthesia for elbow arthroscopy comprises of brachial plexus blockade, interscalene brachial plexus block, Bier block. These blocks are advantageous for the postoperative period by producing excellent results in pain-management control with reduced drug dosages. Regional anesthesia is preferred for patients with many concomitant diseases who are contraindicated to general anesthesia. The main shortcoming is its inability to provide accurate assessment of the neurological status of the extremity after the operation. Furthermore there could be discomfort or even pain during the operation which is caused by the procedure itself or the positioning of the patient. In such cases general anesthesia could be performed. The flaw in Bier's blockade is that the pressure from the tourniquet can cause discomfort the patient and has a risk for systemic toxicity if the tourniquet is rapidly deflated after the intravenous anesthetic is administered.

The mean value of the complications after interscalene block is found to be 1.1%¹. Other complications found in literature include permanent neurological deficiency, or can compromise the cardiovascular and pulmonary status¹.

According the recent literature the preferred type of anesthesia during elbow arthroscopy is the general anesthesia because it provides higher level of comfort for the patient and total muscle relaxation, which in turn removes movements during the operation and eliminates the complications that are linked to regional anesthesia. The shortcomings of the general anesthesia are delayed postoperative recovery and potentially higher levels of pain in the immediate postoperative period.

3. Patient positioning

When elbow arthroscopic surgery is performed the patient can be positioned in supination, lateral decubitus or pronation, depending on the pathology in question and the surgeon's preferences.

Several important principles are described in the literature for patient preparation. All bony prominences must be cushioned with pads, the surgeon must have full 360° access to the elbow. The positioning should allow for unencumbered flexion of the elbow joint for safe placement of the arthroscopic portals. The surgeon should be able

to easily evaluate the intra-articular anatomy and maximum distension of the articular capsule must be possible in order to fulfill the arthroscopic purposes².

The usage of sterile tourniquet allows larger access to the elbow and it is an excellent premise for arthroscopic visualization, allowing safe and efficient procedure. Nevertheless some authors use as proximal as possible unsterile tourniquet without any reports of increased difficulties during the operation or higher risk of complications after.

In the reviewed literature most authors describe the position *lateral decubitus* that is originally described by O'Driscoll and Morrey³. (Fig.1) In this position the patient is placed with the affected upper extremity in upward direction. The patient should be stabilized with tapes and ropes to the table. The upper extremity that will be operated on is secured with the appropriate stand, the shoulder is in flexion and internal rotation of 90° and the elbow joint is in 90° flexion.



Fig. 1. Lateral decubitus position

The pad for the affected limb is placed as proximal as possible from the antecubital fossa so that the anterior neurovascular structures are left uncompressed, to allow maximum distension of the articular capsule and to allow full range of motion of the elbow joint. The contralateral shoulder and elbow are fixated on appropriate for the task additional stands in such a way that they do not obstruct access to the limb that will be operated on.

In this position of the patient, the anesthesiologist has good access to airways. The orthopedic surgeon is unrestricted when manipulating the elbow and has access to the anterior and the posterior compartment of the joint. When is necessary to change the operation to open one with approach to the anterior elbow joint the patient can be easily repositioned. The position in which the patient is in *lateral decubitus* is higher stability capability and unrestricted access to the elbow joint and the upper limb in comparison to the supination position.

In 1985 the *supination* position was described for the first time by Andrews and Carson⁴. In this position the shoulder joint is in 90° abduction. The elbow joint is in 90° flexion and the arm is suspended above the head by using traction device. (Fig. 2).



Fig. 2. Supination position

The positioning of the patient in *supination* has several advantages. The elbow joint is in its anatomical position in respect to the surgeon which allows good and innate orientation. Furthermore, it allows relatively fast preparation and provides unrestricted access to the airways of the patient for the anesthesiologist. Moreover, if a necessity arises for an open procedure the traction can be discontinued and then the open approach can be initiated.

Shortcomings of this position are increased difficulty for arthroscopic access to posterior compartment of the joint and challenging anatomical orientation. Furthermore the traction device can compromise the sterile environment and be unable to provide the necessary stability for the elbow joint during the operation – the need for additional assistant arises.

There is the modified supination position that is also described in which the shoulder joint is in 90° flexion and adduction over the chest area. In this position the access to the posterior compartment is improved compared to the standard supination position. There are many stands and holding devices for these purposes including ones for shoulder arthroscopy that are described in the literature⁵.

The advantage of this position is that the anterior neurovascular structures move away from the capsule which decreases the level of difficulty and risks when working in the anterior compartment⁶. When there is a need for open arthrotomy the arm can be removed from the stand and placed on additional surgical table for fast and comfortable transition to open surgery.

Pronation position is popularized by Poehling et al (1989) (Fig. 3)



Fig. 3. Pronation position

After general anesthesia or regional block, the patient is placed in pronation close to the edge of the operating table on stands. The shoulder joint is in 90° abduction and the upper limb is stabilized with a stand that allows elbow flexion and distension of the joint while using gravitational forces. Some of the authors view regional blockage as inadequate and try to avoid it because postoperatively the neurological function impossible to be evaluated.

The shoulder joint must be tested for full range of motion so an unrestricted area is provided for the manipulation of the elbow. This position has similar advantages and shortcomings to the *Lateral decubitus* position. The more difficult access for the anesthesiologist is one of the deficiencies⁸, another one is the possibility for compression of the antecubital fossa. The latter is undesirable and a way to circumvent it is to rotate the table 20° to the side of the surgeon⁷. In this way the access is improved and the possibility of developing this complication is lowered. The anatomical position of the elbow joint and the good across-the-board access are advantageous to the surgeon.

4. Instrumentation in elbow arthroscopy

The instrumentation has been borrowed knee and elbow arthroscopy on account of being used decades before the shoulder one. Thirty and seventy degrees arthroscope are generally used, from 1985 to present days the 4mm and 30° arthroscopes have become a standard for elbow arthroscopy. 2.7 mm arthroscopes are used infrequently⁹. The 70 degrees arthroscope is advantageous when the elbow joint has decreased range of motion^{10, 11}. The equipment includes: variable in shape and size graspers, probes, conical or dull trocar, mechanical shavers, arthroscopic scissors, arthroscopic retractors and chisel. The latter are described extensively in relation to the arthroscopic resection of osteophytes¹².

Some authors describe the application of interchangeable system of cannulas for mineralization of the tissue damage and extravasation of liquid when change in portals is needed for visualization or in case of substitution of arthroscopes is required. Arthroscopic pump with low pressure or gravitational flow of liquid is used for distension of the elbow joint. The utilization off mechanical pump is related with higher risk of rupture of the articular capsule and as a result the pressure must not exceed 30 mm/hg⁶. In the literature is described also an arthroscopic irrigation system that can maintain constant pressure in the joint through automatic control of the infusion and the secreted liquid in the joint¹³.

5. Portals in elbow arthroscopy

The arthroscopic portals, which are described in the literature are classified as: anterior, Posterior, lateral, and accessorial. The selection of arthroscopic portals depends on the surgeon's preferences and the indications related to the specific treatment. The anatomical bony landmarks are beneficial for the safety when entering into the joint.(Fig.4)



Fig. 4. Arthroscopic portals and marking the bony landmarks

The authors advise that the elbow joint is distended with saline before the creation of any portal. This can happen when the joint is flexed, trough the lateral “soft spot” of the elbow or posterolateral trough *fossa olecrani*. Injecting saline into the joint expands the joint capsule and increases the distance between the bone and *n. medianus* with 12mm, *n. radialis* with 6mm, but it does not increase the distance from *n. ulnaris*^{14, 15}. The distance nerve/capsule is left unchanged when administering solution into the joint as a result they stay in close proximity. Flexion of the elbow joint when compared to extension increases the mean distance between bone and nerve with 5mm for *n. medianus*, 6-10mm for *n. radialis* and 3-5mm for *n. ulnaris*. Using this method are avoided neurological complications when inserting the trocar and the cannulas.

The elbow joint can accommodate around 20-30 ml of liquid in 70° flexion⁶. An elbow joint that has a contracture has thicker capsule and has lower compliance to expansion (up to 15%). Its volumetric capacity is 3-9 ml when flexed in 85°¹⁶. When the joint is in overdistension as a result of saline injection there is a risk of rupture of the articulation capsule. Some authors advise using flow of the liquid that is administered by using gravitational forces instead of pressure pump so the swelling and the extravasation to surrounding tissues is decreased.

The *proximal anteromedial portal*, which is described by Poehling¹⁷, is often used as initial. It provides a good visualization of head of the radius, coronoid process, lateral capsule, and lateral space. Landmarks for this portal are as follows – 2 cm proximal to medial epicondyle and exactly in front of medial intermuscular septum. The position of *n. ulnaris* must be known before the incision for the portal. The trocar is aimed to the head of radius and it is slid onto the anterior aspect of the distal humerus while in close proximity to the bone until it reaches *m. brachialis*, so *n. medianus* is avoided. On that level, *n. ulnaris* is 12 mm posterior, *n. medianus* is 12 mm anterior and *a. brachialis* is 18 mm anterior in relation to the portal¹⁴. The structure with highest risk of damage is the medial antebrachial cutaneous nerve with mean distance of 2.3 mm¹⁸.

The *proximal anterolateral portal*, described by Field et al is positioned around 1-2 cm proximal to lateral epicondyle and directly onto the anterior aspect of the humerus¹⁹. The trocar is aimed at the center of the joint and is glided on anterior aspect of the humerus. It intersects *m. brachioradialis* and the distal part of *m. brachialis*, before it enters the joint through its lateral capsule. It provides good visualization of the anterior aspect of the joint and is often used as starting arthroscopic approach. The structures at risk of damage are *n. radialis* with mean distance of 13.7 mm from the portal and the posterior branch of *n. cutaneus antebrachii medialis* with mean distance of 6.1 (0-14mm) from the portal. The proximal anterolateral portal is safer and it allows for good visualization of the joint when compared to other anterolateral portals²⁰. This portal is safer with flexed elbow joint. *N. medianus* may be in direct contact with the arthroscopic cannula if the elbow joint is fully extended. The portal is initiated when there is 90° flexion laterally, as a result the nerve travels 7-14 mm anteriorly²¹. The brachial artery is shielded by *m. brachialis* and is described to have mean distance away from the portal 15mm (8-20 mm). When there is an anterior transposition of the ulnar nerve this portal should be avoided¹¹. Even though this portal has a possible risk to neurological structures it has the benefit of excellent visualization of the joint.

The *anterolateral portal* is placed 2 cm distally and 2 cm anteriorly in relation to the lateral epicondyle. *N. radialis* and the posterior antebrachial cutaneous nerve are at risk to being damaged when using this portal. The trocar is aimed at the center of the joint and passes through *m. extensor carpi radialis brevis* and *m. supinator*. The arthroscope is inserted into the joint in front of the sulcus between *capitulum humeri* and the head of the radius¹¹. This portal allows for excellent visualization of lateral and medial aspect of the elbow joint, with access to the coronoid process of the radius and head of the radius as well as to *trochlea humeri* and the medial capsule. It can be initially positioned by using the “inside- out” technique by using subcutaneously inserted needle. The benefits of this is avoiding the lateral structures of the joint. The authors prefer proximal anterolateral portal to anterolateral because of the distance to the radial nerve-

3mm), and the distance from the posterior antebrachial cutaneous nerve – 2mm²². The arthroscopic cannula might be in contact with both structures during the procedure especially if the elbow joint is extended²⁰.

Direct lateral portal is positioned at the “soft spot” of the lateral part of the elbow region. The closest neurovascular structure is the posterior antebrachial cutaneous nerve – 7mm. That portal allows visualization to the upper and bottom aspects of *capitulum humeri* and the bottom part of the radioulnar joint. Several lateral portals can be placed between the direct lateral and the proximal anterolateral portal. They allow for possible access from different angles to the lateral area. The more proximal the portal is placed the higher is the risk for radial nerve. Safe method for placement of this portal is the described in the literature technique “inside-out”. The region in which this portal is made is described as the most commonly used for distension of the elbow joint.

In the literature two other arthroscopic portals are described: *postero-central* and *posterolateral*. These portals allow for excellent visualization to the posterior as well as the medial and lateral compartments. The *posterior arthroscopic portal* is placed 2 cm proximally to the top of the olecranon in the midline while the elbow joint is in 90° flexion. It passes through the musculotendinous junction of *m. triceps brachii*. If it is placed too distally – close to the olecranon, there could be possible damage to the tendon of the triceps²³. If the portals are placed accurately the posterior antebrachial cutaneous nerve (23mm distance) and *n. ulnaris* (25mm distance) have low risk to being damaged.

Posterolateral portal is made 2cm proximally to the top of the olecranon and the lateral border of the tendon of *m. triceps brachii*. The trocar is aimed at *fossa olecrani* at 45° and 90° flexion of the elbow joint. Another posterior portal described in the literature is the *posterior retractor portal*²⁴. It is placed 2 cm proximally to the postero-central portal and allows for insertion of retractor which is used to retract the capsule posteriorly and aids the visualization of *fossa olecrani*.

Distal ulnar portal is described by Van Den Ende et al. (2011). It is positioned 3-4 cm distally to the radiocapitellar joint, laterally to the posterior edge of the ulna which can be palpated. This portal is created for the treatment of lesions that are results of osteochondritis dissecans which are localized in the distal and posterior part of *capitulum humeri*²⁵. There are no other indications for this portal described in the literature, but its position allows for innate handling with the arthroscopic tools and avoiding the so called “swordfight” when maneuvering into the joint with the equipment²⁶.

6. Conclusion:

Premise for achieving good to excellent results with minimal percentage of complications are selecting a suitable patient, preoperative preparation, practiced team and adequate equipment. This article’s purpose is to present contemporary methodology for the performance of arthroscopic surgery of the elbow joint.

7. References

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Authors

Tsvetan Tsenkov is a member of the Bulgarian Orthopedic and Traumatology Association (BOTA). He works as an ortopaedic surgeon at the University Hospital of Orthopaedics “Prof. B. Boichev”, Sofia, Bulgaria. He is a PhD candidate from the Department of Orthopedics and Traumatology with a thesis “Arthroscopic treatment of elbow pathology” at the Medical University – Sofia.

Yasen Nikolov is member of the Bulgarian Orthopedic and Traumatology Association (BOTA). He is a resident in ortopaedics and traumatology at the University Hospital of Orthopaedics “Prof. B. Boichev”, Sofia, Bulgaria.

Nikolay Dimitrov is a member of the Bulgarian Orthopedic and Traumatology Association (BOTA). He works as an ortopaedic surgeon at the University Hospital of Orthopaedics “Prof. B. Boichev”, Sofia, Bulgaria. He is assistant professor in orthopedics and traumatology from the Department of Orthopedics and Traumatology at Medical University of Sofia, and also holds a PhD in rotator cuff surgery.