JSES International 7 (2023) 673–677

Contents lists available at ScienceDirect

JSES International

journal homepage: www.jsesinternational.org

Needle arthroscopy of the elbow through an anterior transbrachial portal

Jose M. Rapariz, MD, PhD[a,*], Ana M. Far-Riera, MD[a], Carlos Perez-Uribarri, MD[a], Silvia Martin-Martin, MD, PhD[b], Alfonso Rodriguez-Baeza, MD, PhD[c]

[a]Son Llàtzer Hospital, Palma de Mallorca, Spain
[b]Clinica Rotger, Palma de Mallorca, Spain
[c]Departament of Morphological Sciences (Human Anatomy and Embryology Unit), Faculty of Medicine, Universitat Autònoma de Barcelona, Barcelona, Spain

A R T I C L E I N F O

Keywords:
Elbow arthroscopy
Anterior portal
Transbrachial portal
Needle arthroscopy
Nanoscope
Safety

Level of evidence: Anatomy Study; Cadaver Dissection

Background: Current innovation in needle arthroscopy is improving the safety of anterior portals around the elbow. This study evaluated the proximity to the radial nerve, median nerve, and brachial artery on cadaveric specimens of an anterior portal used for elbow arthroscopy.
Methods: Ten fresh-frozen adult cadaveric extremities were used. After marking the cutaneous references, the NanoScope cannula was introduced just lateral to the biceps tendon, through the brachialis muscle and the anterior capsule. Elbow arthroscopy was performed. Dissection was then carefully performed on all specimens with the NanoScope cannula in place. The shortest distance from the cannula to the median nerve, radial nerve, and brachial artery was measured with a handheld sliding digital caliper.
Results: The cannula was an average of 12.92 mm away from the radial nerve, 22.27 mm from the median nerve, and 16.8 mm from the brachial artery. Needle arthroscopy performed through this portal allows complete visualization of the anterior compartment of the elbow, as well as direct visualization of the posterolateral compartment.
Conclusion: Needle arthroscopy of the elbow through an anterior transbrachialis portal is safe for the main neurovascular structures. In addition, this technique allows complete visualization of the anterior and posterolateral compartments of the elbow through the humerus-radius-ulna space.

Elbow arthroscopy is a technically demanding procedure. The close relationship with neurovascular structures makes it mandatory to understand its neurovascular anatomy.[7,9] The median and radial nerves lie in close relation to the anterior aspect of the elbow and are at risk of iatrogenic injury when performing elbow arthroscopy.

Over the past decades, multiple authors described several arthroscopic portal locations and their relationship with the neurovascular structures.[1,4-10,15-17] The most common portals used to access the anterior elbow compartment include the proximal anterolateral and mid anterolateral portals from the lateral side, and the proximal anteromedial portal on the medial side. Other anterior portals were discarded due to the risk of injury to critical neurovascular anatomy, mainly the radial and median nerves and the brachial artery.

Current innovation of needle arthroscopy might help facilitate improved safety of new portals around the elbow.[12-14]

We questioned whether arthroscopic access to the anterior compartment of the elbow from an anterior portal was possible and the risk of injury to the main neurovascular tissue with this approach.

The purpose of this study was to evaluate the proximity to the radial nerve, median nerve, and brachial artery on cadaveric specimens of an anterior portal used for elbow arthroscopy.

We hypothesized that the anterior portal maintains safety margins (defined as 10 mm) comparable to classic portals.

Materials and methods

Ten fresh-frozen adult cadaveric extremities were used for the present study. All cadavers were collected from persons who had expressed the willingness to donate their bodies for medical and scientific purposes signing a form approved by the Human Experimentation Ethics Committee of the Universitat Autònoma de

Institutional review board approval was not required for this study.

This work was performed at the Department of Morphological Sciences (Human Anatomy and Embryology Unit). Faculty of Medicine, Universitat Autònoma de Barcelona, Barcelona, Spain.

*Corresponding author: Jose M. Rapariz, MD, PhD, C/ Vista Alegre 23, 1 D, Palma de Mallorca 07015, Spain.

E-mail address: jrapariz@gmail.com (J.M. Rapariz).

https://doi.org/10.1016/j.jseint.2023.02.012
2666-6383/

Figure 1 References for portal placement were: on the transverse plane, the flexion crease of the elbow. This line is parallel to the virtual line connecting medial and lateral epicondyles of the elbow, and on the sagittal plane just lateral to the biceps tendon.

Figure 2 The shortest distance from the nerve or artery to the cannula was measured. This distance constitutes the radius of the circle in which the nerve or artery are tangential at a single point.

Barcelona (procedure 2904 approved on March 27, 2015). None of the specimens had evidence of prior surgery or injury to the elbow. All were verified for full elbow range of motion. Specimens were amputated at the level of the proximal humerus for fixation purposes. The median age of the donors at the time of death was 81 years (range, 62-92 years). There were 7 male and 3 female specimens and 5 right and 5 left extremities. After being stored at −20°C, the specimens were thawed to room temperature prior to dissection.

The NanoScope arthroscopic system (Arthrex, Naples, FL, USA) was used. This system consists of a disposable handpiece and a tablet-like control unit. An light emitting diode light source is included in the handpiece. The handpiece tube is 9.5 cm long, semirigid, and has a 1.9 mm outer diameter. The scope's direction of view is 0°, with a 120° field of view. The cannula has a 2.26 mm outer diameter.

The first phase of the study entailed placing the elbow on the table in 60° of flexion. The humerus was fixed with a pressure clamp, and the height was adjusted using a goniometer to hold the elbow at 60° of flexion. We did not use transfixing Steinman pins to avoid interference with the arthroscopic examination of the joint.

References for portal placement were: 1) on the transverse plane, the flexion crease of the elbow. This line is parallel to the virtual line connecting medial and lateral epicondyles of the elbow, and 2) on the sagittal plane just lateral to the biceps tendon.

Marks were made on the skin to provide accurate reference points for portal placement (Fig. 1). Both the cephalic vein and the lateral antebrachial cutaneous nerve are located in the subcutaneous plane of this anterior portal. Therefore, it is convenient to dissect and protect them through a 2 cm transverse incision. Through this incision, the cephalic vein was identified and retracted laterally. When the lateral antebrachial cutaneous nerve was identified, it was retracted laterally as well. The sharp trocar was introduced into the joint, pointing to the olecranon on the axial plane.

The NanoScope was introduced through this cannula into the joint to confirm intra-articular placement. The pump pressure was set to 30 mm Hg, and the anterior compartment arthroscopy was recorded. The Video 1 shows the entire steps of the arthroscopic procedure.

The second phase was an open anatomic dissection. Before beginning the dissection, the pump was stopped to allow the joint to be emptied. Dissection was then carefully performed on all specimens with the NanoScope cannula in place.

Skin and subcutaneous tissues were removed, and the muscles penetrated by the cannulas were documented. The radial nerve was identified in the interval between the brachialis and the brachioradialis muscles and traced distally as it penetrated the supinator muscle. The median nerve was then identified under the lacertus fibrosus and traced proximally.

A single observer performed all measurements. Measurements were performed with a handheld sliding digital caliper calibrated to 0.01 mm. Measurements were made from the medial aspect of the radial nerve to the lateral aspect of the cannula and from the lateral aspect of the median nerve to the medial aspect of the cannula. The shortest distance from the nerve or artery to the cannula was measured. This distance constitutes the radius of the circle in which the nerve or artery is tangential at a single point (Fig. 2)

Results

None of the portal cannulas came in contact with the main neurovascular structures, and distances between portals and such tissue were sufficiently high.

Table I
Distance from the canula to the radial and median nerve.

Specimen	Radial nerve	Median nerve	Brachial artery
1	10.73	26.89	20.78
2	10.06	23.31	20.18
3	9.08	20.16	18.95
4	13.58	20.96	19.63
5	9.94	22.76	18.45
6	13.38	29.29	17.28
7	14.65	19.11	17.61
8	10.3	20.23	21.38
9	15.54	21.06	13.99
10	12.92	18.93	13.74
Standard deviation	2.26	3.41	2.63
Average	12.018	22.27	18.199

The cannula was an average of 12.92 mm (standard deviation [SD] 5.61 mm) away from the radial nerve, an average of 22.27 mm (SD 3.41 mm) away from the median nerve, and an average of 16.8 mm (SD 3.13 mm) away from the brachial artery. Data and measurements are summarized in Table I.

In all cases, it was possible to perform elbow arthroscopy through the anterior portal previously described. Elbow arthroscopies were recorded. This portal allowed complete visualization of the anterior compartment of the elbow, including the proximal and distal capsular insertion. This visualization is comparable to that obtained with the combined anterolateral and anteromedial portals but without the need to interchange the position of the scope.

In addition, the small diameter of the cannula allowed direct access to the posterolateral aspect of the elbow. This access is achieved through the space between the humerus, ulna, and radius, just above the proximal radioulnar joint, which we have named as "HURT" ("humerus-ulna-radius through") (Fig. 3).

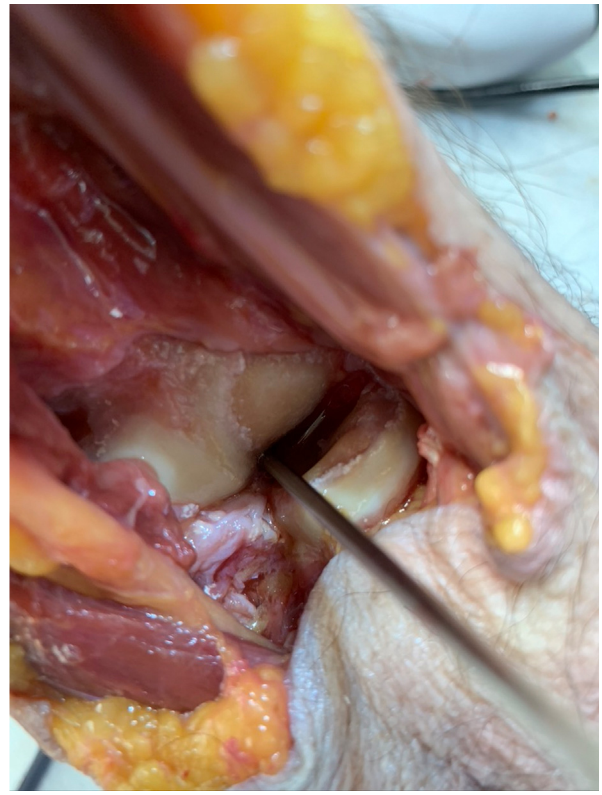

Figure 3 The small diameter of the cannula allowed direct access to the posterolateral aspect of the elbow, through the space between the humerus, ulna, and radius, just above the proximal radioulnar joint.

During superficial dissection, the proximity of the cephalic vein is verified. However, this proximity was not determined in this study. Nor did we measure the distance from the cannula to the brachial cutaneous nerves.

After removing the subcutaneous tissue, the cannula pierces the brachialis muscle in all cases. When deep planes are dissected, a triangular space with a proximal base and a distal apex can be seen. The lateral border of this triangle is the radial nerve itself, and the medial border is the biceps tendon. Due to this triangular configuration, the more proximally the access site is located then the further it is from the radial nerve in the 10 specimens evaluated. (Fig. 4)

Discussion

The elbow is a complex joint. Unlike the knee joint, the neurovascular structures at risk on the elbow are located anteriorly. For this reason, the anterior region of the elbow has not been considered for an anterior portal and would be considered "suicidal" due to the theoretical risk of injury to important vessels and nerves. Multiple studies have been published to assess the risk of neurovascular injury from the classic, medial, and lateral portals.[4,5,9-13] However, we are unaware of any other anatomical study assessing the risk from an anterior portal.

Until now, elbow arthroscopy allows a peripheral view of the joint. This is due to the narrow space separating the humerus's articular surfaces from the ulna and radius. However, the development of needle arthroscopy has allowed the use of smaller diameters and more flexible optics.[12-14] Thanks to this great technological advance, elbow arthroscopy is no longer limited to peripheral vision but rather allows access to the very center of the joint. We have shown that, following the references indicated in this article, the NanoScope can be introduced through the HURT space. In this way, it is possible to visualize the proximal radioulnar joint as well as the posterolateral compartment, which was classically accessed exclusively through an independent portal called the "soft spot".

Several portals have been described to access the elbow joint's anterior compartment. Three of these approaches from the lateral aspect, and the other three from the medial side.[3] However, the denomination and description of these portals are often redundant and complex. As with the classic lateral and medial portals, when performing the anterior transbrachialis portal, we must avoid the use of distal portals. We must not go distal to the elbow flexion crease; otherwise, the distance to the radial nerve is significantly shortened. This is explained by the configuration of the previously described triangular space, in which the radial nerve constitutes the lateral edge of the triangle (Fig. 4)

In order to compare the mean distance between the different portals and the median and radial nerves, we followed the scheme proposed by Camp.[3] This author distinguishes 3 medial portals and 3 lateral portals to access the anterior compartment of the elbow. Comparing the distances between the different portals, we can verify that the anterior transbrachialis portal is further from the median, radial, and brachial artery than any of the classic portals (Table I).

Although the anterocentral transbrachialis portal has been previously described, it was published as a technical note and is not based on any cadaver study.[11] Moreover, they used 8 mm cannulas, which greatly narrows the safety margins with respect to neurovascular structures. In addition, they propose the transbrachialis portal as a working portal, not a viewing portal.

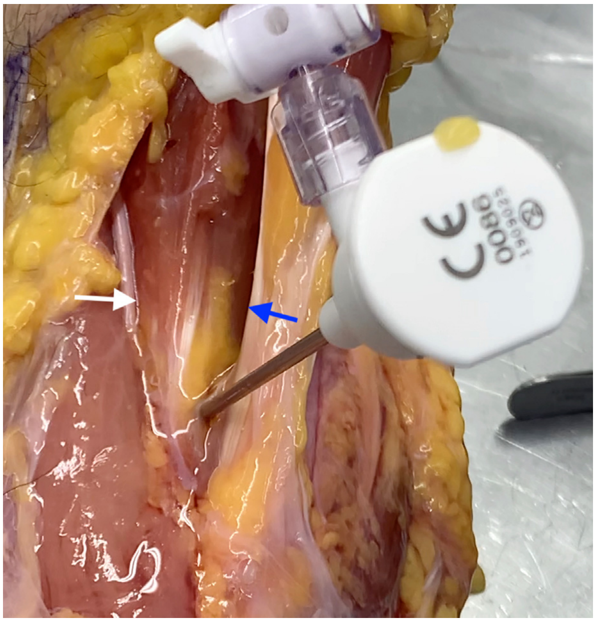

Figure 4 A triangular space with a proximal base and a distal apex can be seen. The lateral border of this triangle is the radial nerve itself (white arrow), and the medial border is the biceps tendon (blue arrow). The more proximal, the safer access will be.

To perform this portal, the patient must be placed in the supine position. The anterior portal cannot be performed in the lateral decubitus or prone position. The main advantages of the supine position are: 1) it facilitates adding open surgical procedures, such as ulnar decompression; and 2) it facilitates access to the airway by the anesthesiologist.[2] However, access to the olecranon fossa is more uncomfortable in this position. Some authors propose leaving the upper extremity completely free for the access to the posterior portals.[11] Strengths and limitations of the anterior portal are listed in Table II

Another advantage of this portal is direct access to the posterolateral chamber of the elbow by introducing the NanoScope through the HURT space. This could be especially useful when débridement of this area is necessary, for example, in cases of posterolateral plica.

Limitations of this study are those common to cadaveric studies. A limited sample size of 10 specimens implies that age or sex bias cannot be excluded.

We did not measure the distance to the cephalic vein or the cutaneous nerves, especially the lateral antebrachial cutaneous nerve, as their close proximity mandates open dissection.

Another limitation of the study is that the distances in different degrees of flexion-extension or prone-supination of the elbow were not measured. The study was carried out with the elbow at 60 degrees of flexion, selected arbitrarily.

Measurements were taken once the pressure pump had been turned off and the joint emptied of saline. It is possible that these measurements are different from those that exist during arthroscopy with joint filling.

Finally, we did not measure how proximally the portal can be moved and yet still access the anterior compartment of the elbow.

Conclusions

Needle arthroscopy of the elbow through an anterior transbrachialis portal provides safe margins for the radial nerve, median nerve, and brachial artery. In addition, this technique allows complete visualization of not only the anterior compartment but also the posterolateral compartment of the elbow through the HURT space.

Table II
Strengths and limitations of the anterior portal.

Strengths
1. Strengths of the supine position:
a. Unobstructed access to the airway for anesthesia
b. Arm freely positioned in space
c. Easy conversion to open procedure, if required.
2. Complete visualization of the anterior compartment through a single portal.
3. Complete visualization of the proximal radioulnar joint
4. Complete visualization of the posterolateral compartment through the HURT space
Limitations
1. Access to the posterior compartment may be more cumbersome

HURT, humeral-ulnar-radius through.

Disclaimers:

Funding: No funding was disclosed by the authors.
Conflicts of interest: The authors, their immediate families, and any research foundation with which they are affiliated have not received any financial payments or other benefits from any commercial entity related to the subject of this article.

Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.jseint.2023.02.012.

References

1. Adolfsson L. Arthroscopy of the elbow joint: a cadaveric study of portal placement. J Shoulder Elbow Surg 1994;3:53-61.
2. Camp CL, Degen RM, Dines JS, Sanchez-Sotelo J, Altchek DW. Basics of elbow arthroscopy part II: positioning and diagnostic arthroscopy in the supine position. Arthrosc Tech 2016;5:e1345-9. https://doi.org/10.1016/j.eats.2016.08.020.
3. Camp CL, Degen RM, Sanchez-Sotelo J, Altchek DW, Dines JS. Basics of elbow arthroscopy part I: surface anatomy, portals, and structures at risk. Arthrosc Tech 2016;5:e1339-43. https://doi.org/10.1016/j.eats.2016.08.019.
4. Cushing T, Finley Z, O'brien MJ, Savoie FH, Myers L, Medvedev G. Safety of anteromedial portals in elbow arthroscopy: a systematic review of cadaveric studies: anteromedial elbow cadaveric review HHS public access. Arthroscopy 2019;35:2164-72. https://doi.org/10.1016/j.arthro.2019.02.046.
5. Field LD, Altchek DW, Warren RF, O'brien SJ, Skyhar MJ, Wickiewicz TL. Arthroscopic anatomy of the lateral elbow: comparison of three portals A. Arthroscopy 1994;10:602-7.
6. Hackl M, Lappen S, Burkhart KJ, Neiss WF, Müller LP, Wegmann K. The course of the median and radial nerve across the elbow: an anatomic study. Arch Orthop Trauma Surg 2015;135:979-83. https://doi.org/10.1007/s00402-015-2228-4.
7. Lynch GJ, Meyers JF, Whipple TL, Caspari RB. Neurovascular anatomy and elbow arthroscopy: inherent risks. Arthroscopy 1986;2:191-7.
8. Marshall PD, Fairclough JA, Johnson SR, Evans EJ. Avoiding nerve damage during elbow arthroscopy. J Bone Joint Surg Br 1993;75:129-31.
9. Miller CD, Jobe CM, Wright MH. Neuroanatomy in elbow arthroscopy. J Shoulder Elbow Surg 1995;4:168-74.
10. Omid R, Hamid N, Keener JD, Galatz LM, Yamaguchi K. Relation of the radial nerve to the anterior capsule of the elbow: anatomy with correlation to arthroscopy. Arthroscopy 2012;28:1800-4. https://doi.org/10.1016/j.arthro.2012.05.890.
11. Otoshi K, Kikuchi S, Kato K, Sato R, Igari T, Kaga T, et al. Arthroscopic elbow debridement using anterocentral transbrachialis portal. Arthrosc Tech 2021;10:e1425-30. https://doi.org/10.1016/j.eats.2021.02.006.
12. Stornebrink T, Altink JN, Appelt D, Wijdicks CA, Stufkens SAS, Kerkhoffs GMMJ. Two-millimetre diameter operative arthroscopy of the ankle is safe and effective. Knee Surg Sport Traumatol Arthrosc 2020;28:3080-6. https://doi.org/10.1007/s00167-020-05889-7.
13. Stornebrink T, Emanuel KS, Shimozono Y, Karlsson J, Kennedy JG, Kerkhoffs GMMJ. A change in scope: redefining minimally invasive. Knee Surg Sport Traumatol Arthrosc 2020;28:3064-5. https://doi.org/10.1007/S00167-020-05898-6.

14. Stornebrink T, Stufkens SAS, Appelt D, Wijdicks CA, Kerkhoffs GMMJ. 2-Mm diameter operative tendoscopy of the tibialis posterior, peroneal, and achilles tendons: a cadaveric study. Foot Ankle Int 2020;41:473-8. https://doi.org/10.1177/1071100719895504.
15. Stothers K, Day B, Regan WR. Arthroscopy of the elbow: anatomy, portal sites, and a description of the proximal lateral portal. Arthroscopy 1995;11:449-57.
16. Thon S, Gold P, Rush L, O'Brien MJ, Savoie FH. Modified anterolateral portals in elbow arthroscopy: a cadaveric study on safety. Arthroscopy 2017;33:1981-5. https://doi.org/10.1016/j.arthro.2017.06.012.
17. Unlu MC, Kesmezacar H, Akgun I, Ogut T, Uzun I. Anatomic relationship between elbow arthroscopy portals and neurovascular structures in different elbow and forearm positions. J Shoulder Elbow Surg 2006;15:457-62. https://doi.org/10.1016/j.jse.2005.09.012.