CURRENT CONCEPTS REVIEW/SOUBORNÝ REFERÁT

Dry Needle Arthroscopy of the Elbow with a 1.9 mm Chip-on-Tip System: a Cadaveric Study

Suchá jehlová artroskopie lokte s 1,9mm systémem Chip-on-Tip: studie na kadáverech

DANIEL REISER, LARS ADOLFSSON, ÁSGERDUR THÓRDARDÓTTIR, MARCUS SAGERFORS

Department of Orthopedics and Hand Surgery, Faculty of Medicine and Health, Örebro University, Örebro, Sweden

Corresponding author:

Daniel Reiser MD, PhD
Senior Consultant Hand Surgeon
Department of Orthopedics and Hand Surgery
Örebro University Hospital
Södra Grev Rosengatan
70185 Örebro, Sweden
daniel.reiser@regionorebrolan.se

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SUMMARY

Arthroscopy has evolved significantly with advancements in instrumentation and surgical techniques. The introduction of needle arthroscopy represents a promising minimally invasive alternative and, has for the wrist proven to offer a reduced soft tissue trauma with still maintained diagnostic and therapeutic efficacy. The purpose of this study was to evaluate the safety and visualization capabilities of needle arthroscopy of the elbow using cadaveric specimens.

Six fresh-frozen cadaveric elbows (three right, three left) were examined using a needle arthroscope, followed by dissection to assess portal safety and proximity to neurovascular structures. The arthroscopic portals evaluated included the proximal anteromedial (PAMP), anteromedial (AMP), mid-anterolateral (MALP), postero-lateral (PLP), direct lateral, and direct posterior portals. The visualization quality of the needle arthroscope was found satisfactory and the smaller diameter (1.9 mm), allowed enhanced maneuverability.

Needle arthroscopy offers improved access and acceptable visualization, potential risks remain, particularly concerning neurovascular structures. Notably, the anteromedial portal was in close proximity to the median nerve and medial antebrachial cutaneous nerve (MABCN), with one documented case of PBMACN (Posterior Branch of the MABCN) injury.

Our results support the use of the needle arthroscope for elbow arthroscopy. However, caution is required to minimize neurovascular injury. Further studies are needed to establish standardized protocols and confirm the long-term safety and efficacy of needle arthroscopy in clinical practice.

Key words: elbow, diagnostic arthroscopy, WALANT, minimally invasive.

INTRODUCTION

Since its initial description in the 1980s, elbow arthroscopy has undergone significant advancements, becoming an established tool in both diagnostic and therapeutic orthopedic procedures (7, 10, 11). Improvements in arthroscopic technology and instrumentation, along with a deeper understanding of the complex anatomical structures surrounding the elbow joint, have transformed what was once considered a high-risk intervention into a reliable and widely used surgical technique. Initially employed primarily for diagnostic purposes, elbow arthroscopy is now routinely utilized for the treatment of various conditions, including loose bodies, osteochondral injuries, lateral epicondylitis, plicae, valgus extension overload, hypertrophic osteoarthritis, contractures, septic arthritis, synovial proliferative disorders, and select fractures (3).

Despite these advances, elbow arthroscopy remains a technically demanding procedure due to the joint's intricate trochoginglymoid structure and its proximity to critical neurovascular elements, such as the median, ulnar, and radial nerves, as well as the brachial artery. While these anatomical structures do not preclude intra-articular access, they necessitate careful planning and execution to minimize the risk of iatrogenic

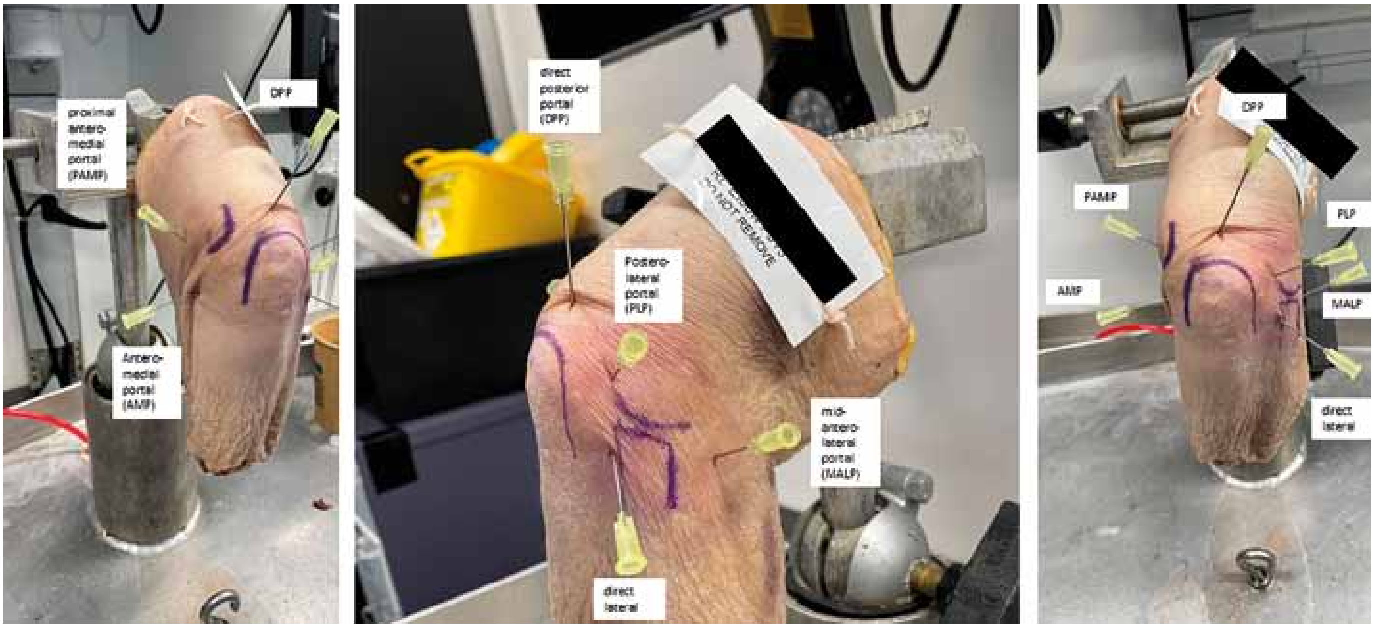

Fig. 1. **The most commonly reported portals using the most commonly accepted nomenclature.**

injury (5). Consequently, various arthroscopic portals have been developed to allow access to all parts of the elbow joint, but also to facilitate safe access mitigating the potential for neurovascular complications. The orthopedic literature describes these portals with varying nomenclature and placement strategies, reflecting ongoing refinements in surgical technique and safety protocols (6). Over the years multiple studies, predominantly based on clinical experience, have explored and refined at least 11 different arthroscopic portals. Alongside the evolution of portal techniques, patient positioning has also been a crucial factor in optimizing surgical outcomes (2, 10, 16). Various positions, including the prone position, supine position with suspended arm, and lateral decubitus positioning, have been investigated for their ability to improve access and visualization while reducing the risk of neurovascular injury.

Given the expanding role of elbow arthroscopy, ongoing research aims to refine techniques and improve patient outcomes. One critical area of investigation involves comparing traditional arthroscopy with emerging new technologies such as needle arthroscopy. Dry needle arthroscopy, a minimally invasive alternative, could potentially reduce soft tissue trauma while maintaining diagnostic and therapeutic efficacy (4, 13, 14). However, its safety and practical utility compared to conventional elbow arthroscopy remains unclear. The present study was designed to evaluate the safety and effectiveness of previously described arthroscopic portals in cadaveric elbow specimens using a dry needle arthroscope. By analyzing different portal configurations and positioning strategies, this study aims to contribute to the ongoing efforts to optimize elbow arthroscopy techniques, enhance patient safety, and improve surgical efficiency.

ANATOMY

The elbow is a complex hinge joint composed of three articulations: the humeroulnar, humeroradial, and proximal radioulnar joints, enabling flexion-extension and pronation-supination movements. Stability is provided by both static and dynamic constraints. Static stabilizers include the bony congruity, the medial and lateral collateral ligament complexes, the annular ligament, and the joint capsule. Dynamic stabilization is achieved through the surrounding musculature, primarily the flexor-pronator and extensor-supinator groups.

A critical aspect of elbow arthroscopy is the identification and preservation of neurovascular structures. The elbow is traversed by several major nerves, including the ulnar nerve, which runs posteriorly in the cubital tunnel, adjacent to the medial epicondyle, making it vulnerable during surgical procedures. The median nerve, coursing through the cubital fossa alongside the brachial artery, is at risk during anterior approaches. The radial nerve, emerging laterally from the posterior compartment, divides into superficial and deep branches near the radial head, where it is susceptible to iatrogenic injury. Additionally, the medial antebrachial cutaneous nerve (MACN), originating from the brachial plexus (C8–T1), provides sensory innervation to the medial forearm and is particularly exposed during medial elbow surgeries. Injury to these structures can result in neuropathic pain, sensory deficits, or functional impairments, highlighting the importance of precise anatomical knowledge when performing elbow arthroscopy.

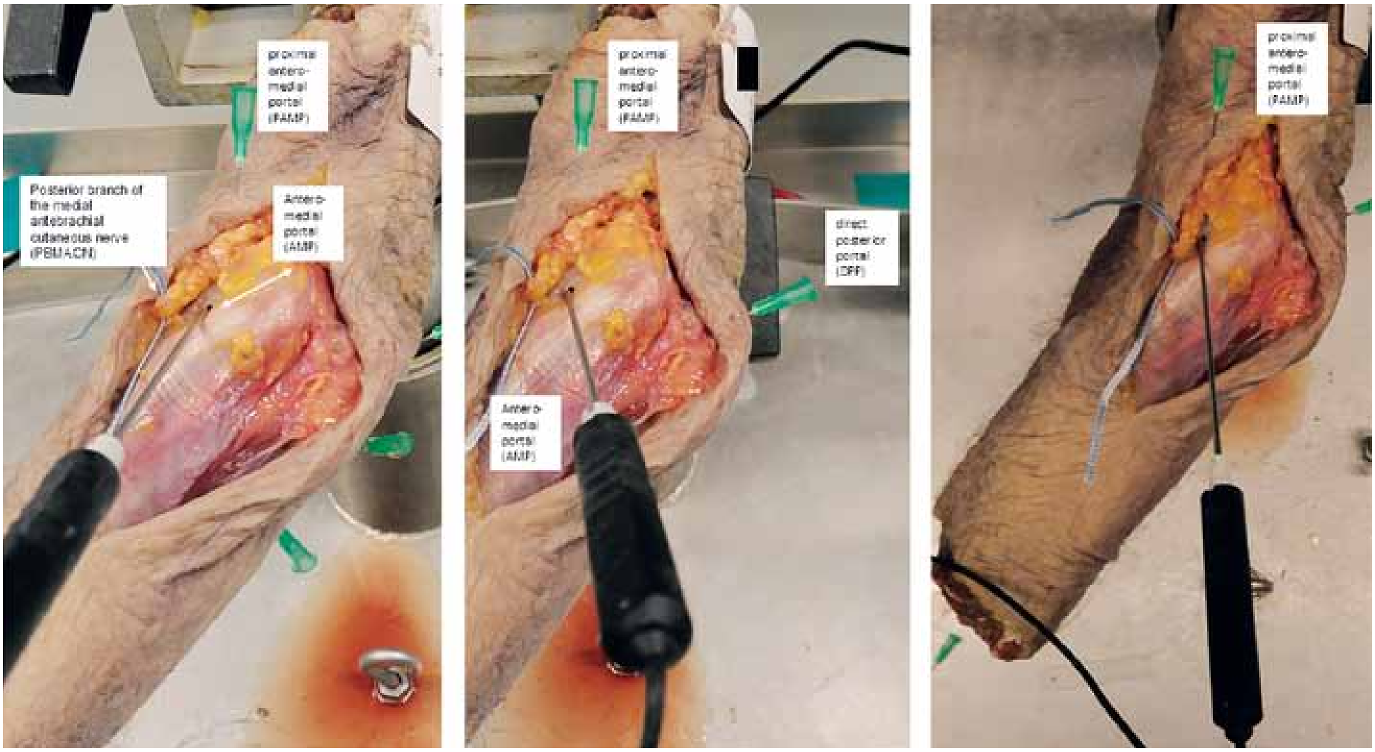

Fig. 2. **Each arthroscopy portal was marked with a probe and the shortest distance from the probe in the respective portal to the various neurovascular structures was measured.**

TECHNIQUE

6 fresh-frozen cadaver elbow joints, 3 right and 3 left, were after thawing first examined with a Needle Arthroscope and then dissected. The most commonly reported portals using the most commonly accepted nomenclature (Fig. 1) (5) were used as follows: proximal antero-medial portal (PAMP) and antero-medial portal (AMP) on the medial side. Postero-lateral portal (PLP), mid-anterolateral portal (MALP) and direct lateral on the lateral side and direct posterior portal (DPP) posterior.

The specimens were fixed in a vice with the posterior side facing up, simulating a lateral decubitus position. During the needle arthroscopy and the dissection, the elbow was secured in the holder while the forearm hung freely at an angle of about 70–90°, depending on tissue tension.

After marking the portals with cannulas, the needle arthroscope was introduced. This angle was maintained throughout the dissection.

The following anatomical points (Table 1) were examined during Needle Arthroscopy examination.

After Needle Arthroscopy, all six cadaver arms were dissected. Each arthroscopy portal was marked with a probe and the shortest distance from the probe in the respective portal to the various neurovascular structures was measured (Fig. 2) in millimeters using a ruler. The mean of the six recorded measurements related to each portal was calculated and decimals rounded off. During the measurement, the elbow joint remained clamped in the holder, while the forearm continued to hang freely, maintaining an angle of approximately 70–90°, depending on the tension of the different cadavers. The angle of the arthroscopy was thus maintained during the dissection.

Table 1. **Image documentation**

VIEW FROM HIGH DORSORADIAL (PLP):	VIEW FROM HIGH DORSORADIAL ABOVE (DIRECT LATERAL)	VIEW FROM ANTEROMEDIAL/ANTEROLATERAL (PAMP, AMP, MALP):
Olecranon tip	Dorsolateral recess	Radius head
Olecranon fossa	Plica humeroradialis	Capitulum humeri
Medial recess	Articulatio humeroradialis	Coronoid process
Lateral recess	Articulatio humeroulnaris	Annular ligament
	Articulatio radioulnaris	

OUTCOMES

The visualization with the Needle Arthroscope was found to be easy and problem-free. The smaller diameter of the Needle Arthroscope was an important factor. Since the Needle

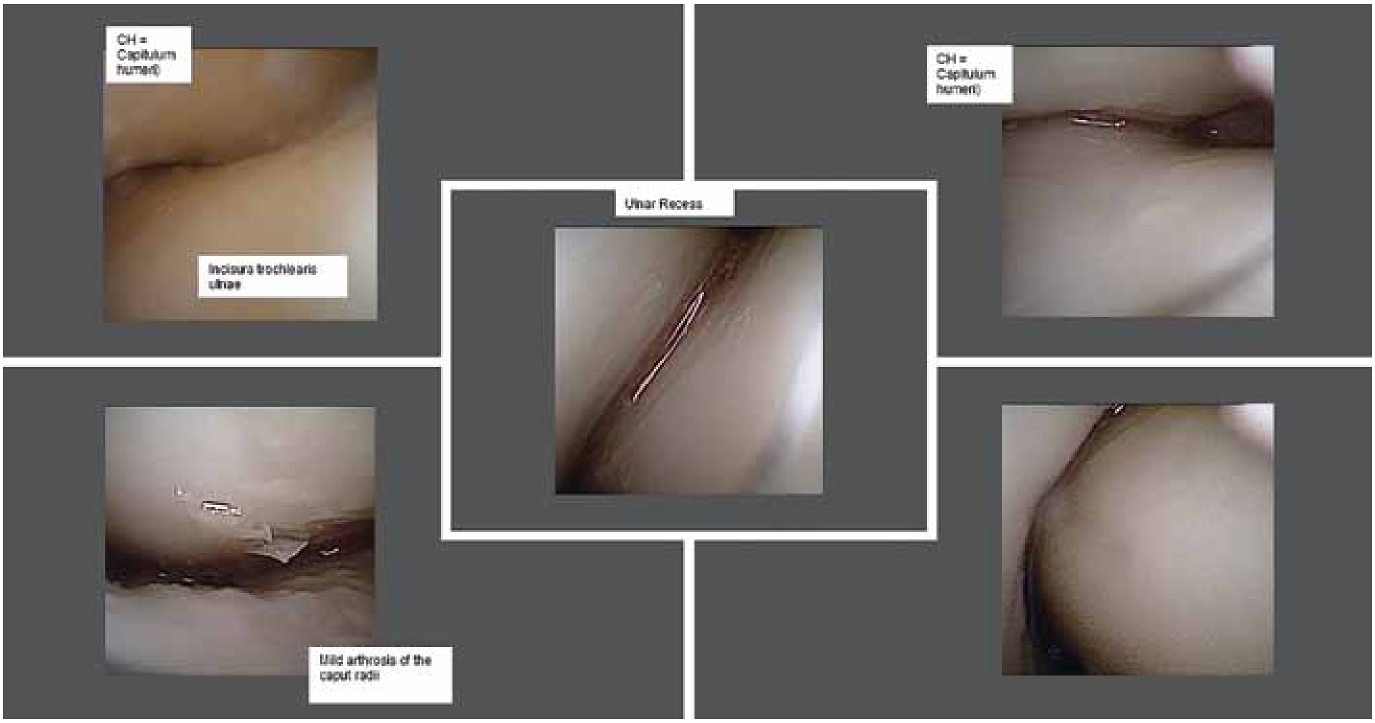

Fig. 3. **The visualized areas with the Needle Arthroscope.**

Arthroscope is flexible and very thin (1.9 mm), maneuvering in the joint was easy. All desired areas were easy to visualize (Fig. 3).

The risks associated with elbow surgery have been well-documented, and our findings reinforce these concerns. The medial portals, AMP and PAMP, sometimes positioned in close proximity to neurovascular structures. The anteromedial portal passed through the flexor-pronator musculature relatively close to the median nerve and the medial antebrachial cutaneous nerve (MABCN. Previous studies have reported that the median nerve lies at an average distance of 5.0 to 7.0 mm from this portal, though some have found distances up to 12.0 mm (2, 8). The MABCN is located between 1.0 and 8.9 mm away, while the brachial artery is positioned at an average distance of 15.2 to 16.6 mm (1, 2). In our cadaver study, the posterior branch of the medial antebrachial cutaneous nerve (PBMACN) was, on average, 3.1 mm from the AMP portal, with one case exhibiting nerve injury (Fig. 4), and 8 mm from the

Table 2. **Mean distance in millimeters, mm and (range)**

PORTAL	1 DIRECT LATERAL	2 POSTEROLATERAL	3 DIRECT POSTERIOR	4 PROXIMAL ANTEROLATERAL	5 ANTEROMEDIAL	6 PROXIMAL ANTEROMEDIAL
n.radialis	13 mm (15–30)	14 mm (4–25)	8 mm (2–30)	5 mm (2–10)		
n.medianus					8 mm (2–25)	13 mm (4–19)
n.ulnaris			23 mm (20–30)		23 mm (19–30)	26 mm (20–35)
art.brachialis					5 mm (2–8)	8 mm (2–8)
posterior antebrachial cutaneous					3 mm (1–7) 1 nerve injury	8 mm (4–11)

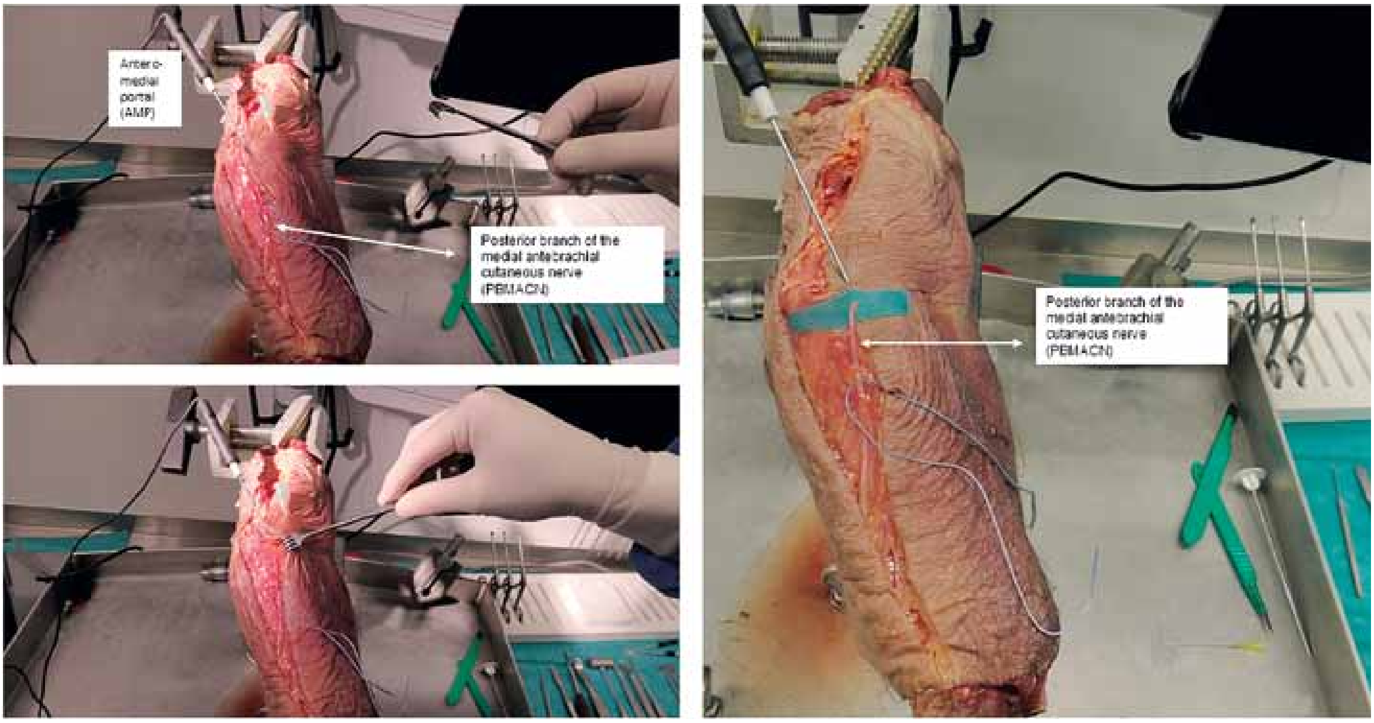

Fig. 4. **The posterior branch of the medial antebrachial cutaneous nerve (PBMACN) was, on average, 3.1 mm from the AMP portal, with one case exhibiting nerve injury (Fig. 3), and 8 mm from the PAMP portal.**

PAMP portal (9, 11, 15). The results are listed in Table 2. There is a risk that the dissection itself influenced the distance to the arthroscopy channels, but we assume that this would only be a few millimeters, if at all.

COMPLICATIONS

The findings indicate that elbow arthroscopy can be performed with the Needle Arthroscope. Initial fluid infusion and distension of the joint capsule as well as 90° flexion have been considered as important factors to increase safety by moving the volar neurovascular structures away from the arthroscopic instruments. The dry needle technique used in the present study precluded this possibility but a smaller diameter arthroscope increases the distance to the neurovascular structures in the area and the measured distances in the present study do not seem to differ significantly from what has been reported with fluid distension and larger diameter scope. Initial fluid distension may still be used with needle arthroscopy and seems both feasible and perhaps recommendable to maximize safety.

The visualization is comparable to that of a normal arthroscope, but the smaller optics provides a smaller field of vision and for a complete examination position of the scope needs to be frequently altered. Although not examined in the present study it appears possible that the smaller field of vision may also make triangulation more difficult and thereby arthroscopic surgery potentially more challenging. On the other hand, the ability to access the joint space between the articular surfaces of the humerus, radius, and ulna may occasionally offer a potential advantage. The smaller diameter and greater flexibility of the Needle Arthroscope proved to be an advantage.

The same risks of injury to important structures exist as with standard arthroscopy. The literature mentions the posterior branch of the medial antebrachial cutaneous nerve (PBMACN) in particular[13]. In one of the six cases, there was injury to the PBMACN.

Patient positioning was not examined but it appears improbable that this would differ from what has already been experienced and reported with larger diameter arthroscope. ■

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