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Original Article

Anatomical landmarks for the radial nerve bifurcation and brachial artery bifurcation in the anterior approach to the elbow: A cadaver study

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Abstract

Aim: The anterior approach to the elbow provides excellent visualization of coronoid process fractures; however, concerns regarding potential neurovascular injury have limited its widespread adoption. This cadaveric study aimed to identify consistent anatomical landmarks for the bifurcation of the radial nerve (RNB) and brachial artery (BAB) in relation to the transepicondylar axis (TEA), with the goal of improving the safety of the anterior elbow approach.
Materials and Methods: Fourteen fresh-frozen adult upper limbs obtained from seven cadavers were dissected. An S-shaped anterior incision was performed, and relevant neurovascular structures, including the radial nerve and brachial artery, were carefully identified. The transepicondylar axis was defined as the line connecting the medial and lateral epicondyles and was used as a reference landmark. Distances from the TEA to the radial nerve bifurcation into superficial and posterior interosseous branches and to the brachial artery bifurcation into the radial and ulnar arteries were measured using digital calipers.
Results: The mean length of the TEA was 57.12 mm. The radial nerve bifurcated at a mean distance of 19.34±2.06 mm proximal to the TEA (range, 17.20–22.27 mm). In contrast, the brachial artery bifurcated at a mean distance of 27.56±6.04 mm distal to the TEA (range, 21.48–35.47 mm). No statistically significant differences were observed between right and left extremities.
Conclusion: This cadaveric study provides precise anatomical reference points for key neurovascular structures encountered during the anterior approach to the elbow. The consistent location of the radial nerve bifurcation approximately 19 mm proximal to the TEA and the brachial artery bifurcation approximately 27.5 mm distal to the TEA may assist surgeons in safely and effectively performing coronoid fixation using the anterior elbow approach.

Keywords: Anterior elbow approach, radial nerve anatomy, brachial artery anatomy, surgical anatomy

INTRODUCTION

Coronoid process fractures may occur as isolated injuries following elbow trauma or as components of complex injury patterns, such as those associated with radial head fractures and posterior elbow dislocations, collectively referred to as the terrible triad of the elbow. Inadequate treatment of these injuries can result in persistent pain, post-traumatic arthrosis, joint instability, the need for reoperation, and loss of range of motion (ROM) (1).

Current treatment algorithms generally advocate fixation of the coronoid fracture as the initial step, followed by fixation or replacement of the radial head and subsequent repair of the lateral collateral ligament complex. Repair of the medial collateral ligament is typically reserved for cases in which residual instability persists after completion of these procedures (2–4). Although consensus exists regarding the surgical management of radial head fractures and lateral collateral ligament repair, the optimal surgical approach and fixation technique for coronoid process fractures remain poorly defined (5).

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Although fixation was historically recommended primarily for large coronoid process fractures based on the assumption that they caused greater elbow instability, it is now recognized that even small coronoid fragments play a critical role in stabilizing the ulnohumeral joint. Accordingly, repair of these fragments has been advocated to prevent posterior translation of the ulna (6,7). For Regan–Morrey type II and type III coronoid process fractures involving larger fragments, posterior-to-anterior fixation using one or two lag screws is commonly recommended, with subcutaneous lateral or medial dissection through a posterior approach when required. In contrast, for type I avulsion fractures, fixation of the anterior capsule using lasso-type sutures through a lateral approach has been suggested (6,8).

Although numerous studies have described posterior, medial, and lateral surgical approaches to the elbow, the anterior approach remains less commonly utilized and has been reported in relatively few studies, largely because of concerns regarding potential injury to adjacent neurovascular structures. Nevertheless, the anterior approach may be applied to both type II and type III large fragment coronoid process fractures as well as type I small fragment avulsion fractures, as it provides direct, wide, and unobstructed access to the fracture site and allows for improved fixation through vertical compression (9).

The aim of this study was to identify reproducible anatomical landmarks that may enhance the safety of the anterior elbow approach by measuring the distances from the transepicondylar axis (TEA) to the radial nerve bifurcation (RNB) and the brachial artery bifurcation (BAB).

MATERIALS AND METHODS

Fourteen adult upper limbs (seven right and seven left) obtained from seven fresh-frozen cadavers (all male) were included in this study. Ethical approval was granted by the Akdeniz University Ethics Committee on November 28, 2018 (meeting no. 70904504/537). The mean age of the cadavers at the time of death was 62 years (range, 45–76 years). All specimens demonstrated no evidence of previous surgical scars, congenital abnormalities, pathological conditions, or a history of prior trauma. All anatomical measurements were obtained using digital calipers.

Surgical Approach

An S-shaped anterior incision was performed as originally described by Henry and later modified by Reichel et al. The incision began approximately 5 cm proximal to the anterior elbow joint line, medial to the biceps muscle, and extended distally for 5 cm along the medial border of the brachioradialis muscle with the elbow maintained in extension. The medial antebrachial cutaneous nerve was identified and carefully protected throughout the dissection.

Following skin and subcutaneous tissue incision, the brachial fascia was divided. The biceps muscle was retracted laterally and mobilized using blunt dissection to expose the underlying neurovascular structures. The brachial artery was identified and followed distally to locate its bifurcation into the radial and ulnar arteries (Figure 1).

The lateral antebrachial cutaneous nerve was identified between the biceps and brachialis muscles and carefully protected throughout the dissection. The bicipital aponeurosis, which extends superficially from the distal biceps tendon to the proximal portions of the superficial flexor musculature, was incised. Particular care was taken during this step to protect the underlying brachial artery and median nerve, which are located immediately deep to the aponeurosis (Figure 1).

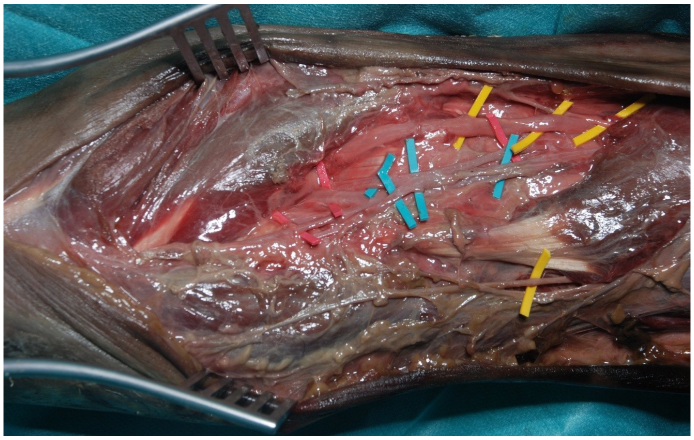

Figure 1. Surgical exposure of the left anterior elbow. Following an S-shaped skin incision, the biceps muscle (white arrow) was retracted laterally. The bicipital aponeurosis was carefully incised to protect the underlying brachial artery bifurcation (BAB; red arrow) and the median nerve (yellow arrow). Proximally, the radial nerve bifurcation (RNB; purple arrow) was identified in the interval between the brachialis and brachioradialis muscles . Dissection was then continued distally to expose the proximal origins of the superficial and deep branches of the radial nerve (posterior interosseous nerve). The medial epicondyle is indicated by the blue arrow.

Proximally, the radial nerve was identified in the interval between the brachialis and brachioradialis muscles and dissected distally. The proximal segments of the superficial branch and the deep branch (posterior interosseous nerve) of the radial nerve were exposed. The brachialis muscle was then split longitudinally to the level of the anterior elbow capsule. The coronoid process of the ulna was palpated, and the elbow joint was accessed through a longitudinal incision in the anterior capsule.

To determine brachial length in each upper extremity, the distance between the acromion and the radial styloid process was measured. With the elbow maintained in full extension and supination, the midpoint between the medial and lateral epicondyles was identified to define the TEA, and its length was measured. The distances from the TEA to the BAB and the RNB were recorded (Figure 2). In addition, the width of the biceps tendon at the level of the TEA was measured and documented.

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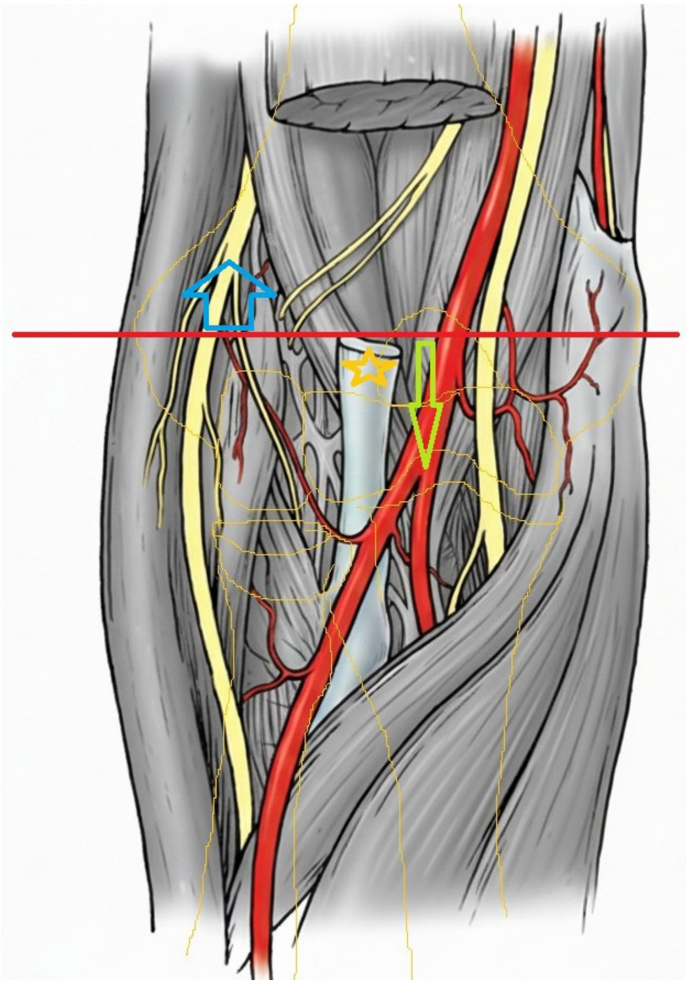

Figure 2. Perpendicular measurements obtained from the transepicondylar axis (TEA; red line) to the radial nerve bifurcation (RNB; blue arrow) and the brachial artery bifurcation (BAB; green arrow), as well as measurement of the width of the biceps tendon at the level of the TEA (yellow star).

RESULTS

The mean distance between the acromion and the radial styloid process was 56.43 cm (range, 51–60 cm). The mean length of the TEA was 57.12 mm (range, 50.3–68.0 mm). The mean diameter of the biceps muscle at the level of the TEA was 16.51 mm (range, 15.1–21.0 mm).

The radial nerve bifurcated at a mean distance of 19.34±2.06 mm proximal to the TEA (range, 17.20–22.27 mm), whereas the brachial artery bifurcated at a mean distance of 27.56±6.04 mm distal to the TEA (range, 21.48–35.47 mm).

No statistically significant differences were observed between right and left upper extremities. In right upper extremities, the radial nerve bifurcated at a mean distance of 19.21±2.58 mm proximal to the TEA (range, 17.30–22.27 mm), compared with 19.46±1.57 mm in left upper extremities (range, 17.2022.30 mm). The brachial artery bifurcated at a mean distance of 27.87±6.16 mm distal to the TEA on the right side (range, 21.48–35.47 mm) and 27.24±6.13 mm on the left side (range, 21.84–35.40 mm).

DISCUSSION

Consensus has not yet been achieved regarding the optimal surgical approach and fixation technique for coronoid process fractures associated with complex elbow injuries, such as the terrible triad, following elbow trauma. Although lateral, medial, posterior, or combined approaches are commonly employed, each is associated with specific technical challenges and limitations (10).

The lateral approach allows reliable access for fixation of the radial head and repair of the lateral collateral ligament complex; however, exposure of the coronoid process is limited, particularly when anterior-to-posterior fixation is required (1). The medial approach necessitates more extensive soft tissue dissection and requires identification and mobilization of the ulnar nerve, thereby increasing the risk of iatrogenic nerve injury. Moreover, similar to the lateral approach, the medial approach presents technical difficulties in achieving anterior-to-posterior fixation of the coronoid process. Consequently, some authors advocate the lateral approach when radial head excision is planned, while favoring the medial approach for coronoid fixation when preservation of the radial head is intended (7).

Reichel et al. reported the use of a combined anterior and lateral approach in six patients with Regan–Morrey type II and type III coronoid process fractures associated with lateral collateral ligament injury and radial head fractures. Coronoid fixation was achieved using screws or plates, and no procedure-related complications were observed. The authors emphasized that the anterior approach provides excellent visualization of the coronoid process and enables stable fixation, even in cases involving small fracture fragments (10).

Similarly, Yang et al. described an anterior elbow approach in a series of 12 patients with isolated coronoid process fractures, utilizing an interval between the brachial artery and the median nerve. No complications were reported, except for mild heterotopic ossification in a single patient. Based on these findings, the authors concluded that the anterior approach is technically straightforward, minimally invasive, offers a wide surgical field, allows for rigid fixation, and facilitates early postoperative mobilization (9).

Numerous anatomical studies investigating lateral and posterolateral approaches to the elbow have quantified the distances of the radial nerve and posterior interosseous nerve from key osseous landmarks, such as the humeroradial joint and the lateral epicondyle, to establish reliable surgical reference points (11–13). In a cadaveric study of 12 upper limbs, Low et al. employed a midline approach through the brachioradialis muscle and reported that bifurcation of the radial nerve into the superficial radial nerve and the posterior interosseous nerve occurred approximately 1.8 cm distal to the lateral epicondyle (14). Similarly, Mekhail et al., in a cadaveric study of 30 upper limbs using the Henry approach to the proximal radius, reported that the radial nerve bifurcation was located 1.1±1.0 cm proximal to the humeroradial joint, while the recurrent radial artery was situated 2.4±0.5 cm distal to the humeroradial joint (15).

In the present study, the radial nerve bifurcated at a mean distance of 19.21±2.58 mm proximal to the TEA in right upper extremities (range, 17.30–22.27 mm) and 19.46±1.57 mm proximal to the TEA in left upper extremities (range, 17.20–22.30 mm). The brachial artery bifurcated at a mean distance of 27.87±6.16 mm distal to the TEA on the right side (range, 21.48–35.47 mm) and 27.24±6.13 mm distal to the TEA on the left side (range, 21.8435.40 mm).

Several limitations of this study should be acknowledged. First, statistical comparisons were limited by the relatively small number of cadaveric specimens. Second, the transepicondylar axis, used as a reference landmark for measurements, represents an imaginary anatomical line rather than a discrete palpable structure. Third, positional changes and potential variations in the relative locations of the nerve and artery at different degrees of elbow flexion were not evaluated. In addition, because this investigation was conducted using cadaveric specimens, the effects of hematoma formation, edema, and inflammation that may be present in a clinical trauma setting could not be assessed.

Despite these limitations, accurate knowledge of the location of the brachial artery bifurcation and radial nerve bifurcation, as well as their relationships to surrounding anatomical structures, is essential for the safe and effective use of the anterior approach to the elbow in clinical practice. These anatomical reference points may facilitate fracture exposure and enable anterior-to-posterior fixation with screws or plates for coronoid process fractures of varying sizes, ranging from Regan–Morrey type I avulsion fractures to type III fractures.

CONCLUSION

The anterior approach to the elbow represents a viable and minimally invasive option for the management of coronoid process fractures, offering direct visualization of the fracture site and facilitating rigid anterior-to-posterior fixation across a spectrum of fracture patterns.

Despite the inherent limitations of cadaveric studies, precise localization of key neurovascular structures relative to the readily identifiable transepicondylar axis substantially enhances the safety of the anterior elbow approach. Surgical exposure 2 cm proximal to the TEA must be performed with extreme caution, as this is reliable danger zone for radial nerve bifurcation and 2 cm distally for brachial artery bifurcation. Surgeons may use the TEA as a reference to anticipate the proximity of these critical neurovascular divisions.

The anatomical measurements presented in this study may serve as reliable reference points, enabling surgeons to safely navigate the surgical field and reduce the risk of iatrogenic injury to the radial nerve and brachial artery during fixation of coronoid process fractures ranging from Regan–Morrey type I avulsion injuries to complex type III fractures.

Conflict of Interests
The authors declare that there is no conflict of interest in the study.

Financial Disclosure
The authors declare that they have received no financial support for the study.

Ethical Approval
This study was approved by the Akdeniz University Ethics Committee on November 28, 2018 (meeting no. 70904504/537).

REFERENCES

1. Ring D, Jupiter JB, Zilberfarb J. Posterior dislocation of the elbow with fractures of the radial head and coronoid. J Bone Joint Surg Am. 2002;84:547–51.
2. Zeiders GJ, Patel MK. Management of unstable elbows following complex fracture-dislocations—the "terrible triad" injury. J Bone Joint Surg Am. 2008;90:75-84.
3. Pugh DM, Wild LM, Schemitsch EH, et al. Standard surgical protocol to treat elbow dislocations with radial head and coronoid fractures. J Bone Joint Surg Am. 2004;86:1122-30.
4. Forthman C, Henket M, Ring DC. Elbow dislocation with intra-articular fracture: the results of operative treatment without repair of the medial collateral ligament. J Hand Surg Am. 2007;32:1200-9.
5. Garrigues G, Wray W, Lindenhovius A, et al. Fixation of the Coronoid Process in Elbow Fracture-Dislocations. J Bone Joint Surg Am. 2011;93:1873-81.
6. Regan W, Morrey B. Fractures of the coronoid process of the ulna. J Bone Joint Surg Am Vol. 1989;71:1348–54.
7. Garrigues GE, Wray WH, Lindenhovius AL, et al. Fixation of the coronoid process in elbow fracture-dislocations. J Bone Joint Surg Am. 2011;93:1873–81.
8. McKee MD, Pugh DM, Wild LM, et al. Standard surgical protocol to treat elbow dislocations with radial head and coronoid fractures. Surgical technique. J Bone Joint Surg Am. 2005;87:22-32.
9. Yang X, Chang W, Chen W. et al. A novel anterior approach for the fixation of ulnar coronoid process fractures. Orthop Traumatol Surg Res. 2017;103:899-904.
10. Reichel LM1, Milam GS, Reitman CA. Anterior approach for operative fixation of coronoid fractures in complex elbow instability. Tech Hand Up Extrem Surg. 2012;16:98-104.
11. Ozkan M, Bacakog˘lu AK, Gül O, et al. Anatomic study of posterior interosseous nerve in the arcade of Frohse. J Shoulder Elbow Surg. 1999;8:617-20.
12. Schimizzi A, MacLennan A, Meier KM, et al. Defining a safe zone of dissection during the extensor digitorum communis splitting approach to the proximal radius and forearm: an anatomic study. J Hand Surg Am. 2009;34:1252-5.
13. Thomas SJ, Yakin DE, Parry BR, Lubahn JD. The anatomical relationship between the posterior interosseous nerve and the supinator muscle. J Hand Surg Am. 2000;25:936-41.

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14. Low CK, Chew JT, Mitra AK. A surgical approach to the posterior interosseous branch of the radial nerve through the brachioradialis–a cadaveric study. Singapore Med J. 1994;35:394-6.

15. Mekhail AO, Ebraheim NA, Jackson WT, Yeasting RA. Anatomic considerations for the anterior exposure of the proximal portion of the radius. J Hand Surg Am. 1996;21:794-801.