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Land marks and safety with respect to radial nerve in distal humeral surgery

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Abstract

The study analyzed 20 elbows from 10 preserved male human cadavers (10 right and 10 left), which were selected based on strict inclusion criteria. Cadavers with a history of prior surgery, infection, trauma or deformity were excluded from the sample. The average age of the cadavers was 46 years, ranging from 28 to 64 years. The precise measurements were obtained using the Microscribe-G2X device, renowned for its accuracy of up to one-thousandth of a millimeter. The length from the pivot point of the radial nerve in the sulcus nervi radialis to the distal end of the humerus is measured, along with the transverse diameter between the lateral epicondyle and the radial nerve and the length of the humerus itself. The length from the pivot point of the radial nerve in the sulcus nervi radialis to the distal end of the humerus is measured, along with the transverse diameter between the lateral epicondyle and the radial nerve and the length of the humerus itself. The length from the pivot point of the radial nerve in the sulcus nervi radialis to the distal end of the humerus is measured, along with the transverse diameter between the lateral epicondyle and the radial nerve and the length of the humerus itself. The right and left sides were measured to be 30.54±0.65cm and 30.54±0.59cm, respectively, with no considerable difference between them. The distance from the pivot point of the radial nerve in the sulcus nervi radialis to the distal part of the humerus was 15.07±1.27cm on the right side and 15.34±1.21cm on the left side. On the right, the distance was 15.07±1.27cm, while on the left, it was 15.34±1.21cm. Moreover, the transverse diameter between the lateral epicondyle and the radial nerve was measured at 2.95±0.14cm on the right side and 3.05±0.13cm on the left side. We contend that comprehension of the safe zone in distal humerus surgery can greatly improve surgical safety.

Keywords: Distal humerus, fractured, radial nerve, safe zone

Introduction

To ensure safety and success in the surgical management of distal humeral fractures, it is imperative to consider the anatomical landmarks and safeguard the radial nerve.

Distal humeral fractures, comprising approximately 2% of all fractures and around a third of elbow fractures, present a challenge due to the complexity of the elbow joint [1].

These fractures can result from either high-energy or low-energy trauma [2]. The choice between conservative and surgical treatment hinges on factors like fracture shape and location. The treatment approach for these fractures may vary based on factors such as fracture severity, location, the patient's age, and overall health. Surgical intervention is commonly employed to restore joint alignment and function, utilizing various surgical techniques and devices such as plates, screws, or pins to stabilize the fracture and facilitate healing.A comprehensive understanding of elbow anatomy is paramount when formulating the surgical approach and reduction strategies [3,4].

The radial nerve is a significant component of the upper extremity's neural network, primarily located in the arm. It originates from the posterior cord of the brachial plexus, formed by the merging of nerve fibers originating from spinal nerves spanning from C5 to T1. These fibers unite to form the radial nerve, which travels along the posterior aspect of the arm. It courses posteriorly to the axillary artery, then descends anteriorly along the latissimus dorsi muscle tendon, passing the teres major muscle. From there, it extends laterally from the lower border of the teres major muscle into the posterior arm region. In the lower half of the arm, the radial nerve is housed within the sulcus nervi

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radialis, which is located between the medial and lateral heads of the triceps brachii muscle. This nerve plays a crucial role in controlling the extensor muscles of the wrist and fingers, as well as the posterior portions of the arm and forearm [5,6].

The term "Sulcus nervi radialis" refers to the groove or canal along the humerus bone, serving as the pathway for the radial nerve. This groove is also commonly known as the radial or spiral groove. The radial nerve follows this groove along the posterior side of the humerus bone as it extends down the arm, providing both motor and sensory innervation to a variety of muscles and anatomical regions, as previously explained. It is essential to protect the radial nerve and ensure its proper positioning within the radial groove to prevent nerve compression or injury.

Injuries to the radial nerve can result from diverse causes, including trauma (e.g., humerus bone fractures or dislocations), compression or entrapment (e.g., due to external pressure on the nerve), or underlying medical conditions. Radial nerve injuries can manifest as symptoms such as weakness in extending the arm or wrist, as well as sensory deficits in the areas it innervates. Damage to the radial nerve is a common occurrence in peripheral nervous system injuries, and it can significantly impact an individual's functional abilities [6-9].

It is crucial to safeguard the radial nerve when positioning plates for fracture fixation and locking screws in locking nails.

This study aims to determine reliable landmarks and establish a correlation with the length of the surgical risky area to minimize nerve damage of the radial nerve during humerus distal surgery. In doing so, the study considers the distance the nerve rotates from the distal end.

The study focuses on minimizing the risk of radial nerve injury during the placement of plates and other implants and determining a safe surgical area. The aim of this study is to determine the changes in each parameter by establishing the correlation between the transverse diameter between the lateral epicondyle and the radial nerve and the length of the humerus, along with new parameters.

Material and Methods

The investigation comprised 20 elbow specimens procured from 10 male formalized human cadavers. Specimens with prior trauma, tumor, infection or surgery were excluded by the researchers. The subjects had an average age of 50 years, within an age range of 32 to 68 years.

The positioning of the specimens was supine, and the arm was rested on the chest. The elbow joint was flexed to 90 degrees, and the shoulder was held in a neutral rotation position.

A vertical central incision was made roughly 4 centimeters below the proximal end of the humerus, extending into the olecranon fossa, to expose underlying tissues. The lateral and long heads of the triceps muscle were identified and longitudinally separated. The triceps muscle is a significant muscle situated on the posterior aspect of the upper arm. The radial nerve passing through the posterior aspect of the humerus was identified distally. This is likely the groove identified as the "sulcus nervi radialis" in which the radial nerve is situated (Figure 1). Several parameters related to the radial nerve were measured, including the distance from the point where the radial nerve curves within the sulcus nervi radialis to the distal part of the humerus, the length of the transverse diameter between the lateral epicondyle and the radial nerve, as well as the length of the humerus itself.

Figure 1. Cadaver dissection photograph. The radial nerve is seen running anteriorly from the radial groove towards the supraepicondylar process

Tools for measurements were also employed. Measurements were taken with the Microscribe-G2X, a precise measuring device that can measure with an accuracy of one thousandth of a millimeter. The measurements were independently recorded by two researchers to ensure accuracy and reliability. Mean and standard deviations were calculated for all measured variables, enabling statistical analysis to summarise the findings and explain data variation.

Results

Humerus Length: The length of the humerus was recorded as 30.54±0.65cm on the right side and 30.54±0.59cm on the left side.

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Radial Nerve Distance: On the right side, the distance between the radial nerve's point of rotation in the sulcus nervi radialis and the distal part of the humerus measured 15.07±1.27cm. On the left side, this distance was slightly longer, measuring 15.34±1.21cm.

Transverse Diameter Length: The transverse diameter length from the lateral epicondyle to the radial nerve measured 2.95±0.14cm on the right side and 3.05±0.13cm on the left side, indicating a slight variation in lengths. The results are shown in Table 1.

Table 1. Descriptive statistics of the measurements (n=20)

	Right	**Left**
Distance	**Mean±SD**	**Mean±SD**
Humerus length	30.54±0.65	30.54±0.59
Rotation of the nerve (distally)	15.07±1.27	15.34±1.21
Transverse diameter from lateral epicondyle to radial nerve	2.95±0.14	3.05±0.13

These measurements provide detailed anatomical information regarding humerus length, radial nerve distance, and transverse diameter length on both sides of the specimens. The data presented includes mean measurements, or averages, along with standard deviations, which offer insights into the distribution and variability of the data around the mean.

Discussion

Radial nerve involvement in upper limb fractures is a frequent issue and highlights the significance of taking into account its location and sensitivity when planning and performing surgical procedures regarding the upper arm and elbow. Expertise and experience are mandatory for elbow surgeries. Hence, it is vital to delineate the anatomical features. In this study, a secure area for safeguarding the radial nerve during surgical procedures has been established. These parameters are.

The mean length of the humerus was 30.54±0.65cm on the right and 30.54±0.59cm on the left. The distance from the point of rotation of the radial nerve in the sulcus nervi radialis to the distal part of the humerus was 15.07±1.27cm on the right and 15.34±1.21cm on the left. The transverse diameter length from the lateral epicondyle to the radial nerve is 2.95±0.14cm on the right and 3.05±0.13cm on the left.

Previous research has reported that the incidence of radial nerve injury during surgical interventions ranges from 4.2% to 5.1%. Despite advancements in surgical techniques and the management of specific fractures, the risk of radial nerve damage persists, particularly in procedures addressing unstable distal humeral fractures [10].

A study conducted by Gerwin et al. provided precise measurements of the radial nerve's position relative to the humerus. The authors noted that the distance between the radial nerve and the posterior aspect of the humerus to the medial epicondyle was approximately 20.7cm, while the distance to the lateral epicondyle was around 14.2cm. These measurements may prove valuable in certain surgical scenarios, although their applicability to more intricate procedures involving the radial groove remains uncertain [11].

Uhl et al. conducted measurements of the radial nerve's position by assessing the distance between the distal humeral articular surface and the sulcus nervi radialis. Their findings indicated a consistent distance of 15.8 cm in males and 15.2cm in females [12]. These measurements likely originated from clinical observations or data collected from live subjects.

The measurements indicate that there could be minor gender disparities in the position of the radial nerve in relation to the distal humeral articular surface, with men having a slightly greater distance than women.

Chaudhry and colleagues have reported that, on average, the radial nerve extends approximately 2.2 to 2.7cm laterally from the outer edge of the triceps aponeurosis. This measurement provides valuable information regarding the radial nerve's position relative to the triceps aponeurosis, a thin connective tissue layer that envelops the triceps muscle [13]. It is worth noting that identifying the triceps aponeurosis using a posterior approach to the humerus is generally straightforward. The triceps aponeurosis serves as a crucial anatomical landmark for surgeons and healthcare professionals conducting procedures in this region. Notably, there can be significant variations in the size and extent of the triceps aponeurosis among individuals, underscoring the importance of accommodating anatomical diversity when planning and executing surgical interventions. As per our study's parameters, the passage suggests that identifying reliable landmarks in surgical approaches can be advantageous in minimizing the risk of radial nerve injury. These reference points provide surgeons with a dependable orientation to prevent nerve damage during procedures.

Jain et al. found that the mean distance from the posterior aspect of the humerus to the medial epicondyle of the radial nerve is 18.5±0.79cm, while the distance from the proximal aspect to the lateral epicondyle is 11.34±0.41cm. Additionally, they determined that the median length of the radial nerve within the spiral groove falls within the range of 4.3±0.75cm.

Previous research has indicated that surgical procedures involving the radial nerve in this region may carry a risk of injury [14]. These findings underscore the importance of careful consideration of posterolateral access to the distal humerus during surgical procedures. Furthermore, our study examined the relationships between the measured distances, utilizing a Microscribe device known for its precise measurements, with a sensitivity down to one-thousandth of a millimeter.

Hackl et al. reported an average humerus length of 30.8 cm (±1.9cm) in their study. Similarly, in our study, we measured the length of the humerus on both the right and left sides, resulting in measurements of 30.54±0.65 cm and 30.54±0.59 cm, respectively. These findings are consistent with previous literature. Additionally, the researchers obtained an average transcondylar width measurement of 6.3 cm (±0.6cm; ranging from 5.1 to 7.6cm) and a distance of 15.0 cm (±2.1cm) between the medial edge of the humeral shaft, just behind the olecranon fossa, and the radial nerve. We should note that technical abbreviations, such as "cm," are explained upon their initial use.

Furthermore, the average distance between the olecranon fossa on the lateral border of the posterior surface of the humeral shaft and the radial nerve was measured at 10.6cm (±1.3cm), with a range spanning from 10.6 to 19.5cm [15]. This study provides valuable insights into the precise localization of the radial nerve along the arm. Abbreviations for technical terms are clarified when introduced. The writing maintains a formal and objective tone, avoiding colloquial language or unnecessary embellishments. Causal relationships are clearly presented throughout the text, and the language is devoid of grammatical errors and structural issues. Our study's parameters can serve as practical landmarks for guiding surgical procedures.

Ensuring the safety of surgical interventions in the distal humerus is of utmost importance. Defining and understanding a safe zone in this region is essential in reducing the risk of complications and enhancing surgical outcomes.

To avoid radial nerve injury, it is advised to use wide incisions and blunt dissection techniques. Such approaches provide better visualization of anatomical structures and enable careful nerve handling during the surgery.

Limitations

Our lack of information on different age groups and different sexes is a limitation of the present study.

Conclusion

Familiarity with the safe zone in distal humerus surgery further enhances safety. Ensuring safety during surgical intervention of the humerus necessitates identification and protection of the radial nerve.

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 This study was approved by the Antalya training and research hospital, Orthopedics and Traumatology Clinic, Antalya, Türkiye, Non-Invasive Clinical Research Ethics Committee, dated 07.09.2023 and numbered 12/7.

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