HEALTH RESEARCH IN AFRICA
High Quality Research with Impact on Clinical Care

Research Article

Specification of the Contact Zone between the Lateral Surface of the Humerus and the Radial Nerve

Spécification de la Zone de Contact entre la Surface Latérale de l'Humérus et le Nerf Radial

Yves Roger Djembi[1, 3], Rodrigue Abiome[1], Anicet Mikiela[1], YE. James[2], Louis Stanislas Bayonne Manou[1], Pierre Trouilloud[3], Nicolas Cheynel[3], David Guillier[3]

Affiliations
1. Department of Surgery-Anatomy, University of Health Sciences of Owendo, Gabon
2. Anatomy Laboratory, Faculty of Health Sciences, University of Lomé, Togo
3. Anatomy Laboratory, UFR of Health Sciences, University of Burgundy, France

Auteur correspondant
Yves Roger Djembi
Email :yrdjembi@hotmail.com

Mots clés : Humérus, Nerf radial,anatomie, cas reporté
Key words: humerus, radial nerve, reports, anatomy

ABSTRACT

Introduction. The radial nerve is often affected in humeral fractures with radial palsy being one of the most serious complications. The aim of our study was to specify the contact zone between the lateral surface of the humerus and the radial nerve in France. **Methodology**. The anatomical laboratory study of the radial nerve reports on the lateral aspect of the humerus was performed on 15 arms of 15 fresh subjects in the anatomy laboratory of the UFR of Health Sciences, University of Burgundy, France. Two bodies were preserved using the Thiel technique and 13 with formaldehyde. We determined 4 measurements: humerus length A: lateral epicondyle, apex of trochiter; distance B: inferior border of lateral epicondyle, end of radial nerve crossing with lateral aspect of humerus; distance C: inferior border of lateral epicondyle, distal end of the nerve crossing and humerus. **Results.** Our study was carried on 15 arms. The average humerus length was 29 cm, with extremes from: 25.5-33.5 cm. The average distance B was: 13 cm (9-14.5 cm). The average distance C was: 7.3 cm (5-8 cm). In the longest humerus, the distal limit averages 7 cm, and the proximal average is less than 14 cm.The crossing zone is located between 5 and 14.5 cm from the lateral epicondyle. In the longest humeri, the distal limit is on average 7 cm, and the proximal limit is less than 14 cm. **Conclusion.** If the humerus is divided into 7 equivalent sectors: the distal SL sector is free, and the radial nerve crosses the lateral face of the humerus above the free SL sector. The location of this contact zone provides reliable data to avoid iatrogenic lesions of this nerve.

RESUME

Introduction. Le nerf radial est souvent affecté dans les fractures humérales, avec la paralysie radiale étant l'une des complications les plus graves. Le but de notre étude était de préciser la zone de contact entre la surface latérale de l'humérus et le nerf radial en France. **Méthodologie.** L'étude anatomique du nerf radial sur la face latérale de l'humérus a été réalisée sur 15 bras de 15 sujets frais au laboratoire d'anatomie de l'UFR des Sciences de la Santé, Université de Bourgogne, en France. Deux corps ont été conservés en utilisant la technique de Thiel et 13 avec du formaldéhyde. Nous avons déterminé 4 mesures : longueur de l'humérus A : épicondyle latéral, sommet du trochiter ; distance B : bord inférieur de l'épicondyle latéral, fin de la traversée du nerf radial avec la face latérale de l'humérus ; distance C : bord inférieur de l'épicondyle latéral, extrémité distale de la traversée du nerf et de l'humérus. **Résultats.** Notre étude a porté sur 15 bras. La longueur moyenne de l'humérus était de 29 cm, avec des extrêmes de 25,5 à 33,5 cm. La distance moyenne B était de 13 cm (9-14,5 cm). La distance moyenne C était de 7,3 cm (5-8 cm). Dans les humérus les plus longs, la limite distale était en moyenne de 7 cm, et la limite proximale était inférieure à 14 cm. La zone de croisement se situe entre 5 et 14,5 cm de l'épicondyle latéral. Dans les humérus les plus longs, la limite distale est en moyenne de 7 cm, et la limite proximale est inférieure à 14 cm. **Conclusion.** Si l'humérus est divisé en 7 secteurs équivalents : le secteur SL distal est libre, et le nerf radial traverse la face latérale de l'humérus au-dessus du secteur SL libre. L'emplacement de cette zone de contact fournit des données fiables pour éviter les lésions iatrogènes de ce nerf.

HIGHLIGHTS

What is known of the subject

The radial nerve is often affected in humeral fractures with radial palsy being one of the most serious complications

The aim of our study

Specify the contact zone between the lateral surface of the humerus and the radial nerve

Key Results

1. The average humerus length was 29 cm
2. The crossing zone is located between 5 and 14.5 cm from the lateral epicondyle.
3. In the longest humeri, the distal limit is on average 7 cm, and the proximal limit is less than 14 cm.
4. If the humerus is divided into 7 equivalent sectors:, the distal SL sector was free, and the radial nerve crossed the lateral face of the humerus above the free SL sector.

Implications for future practices and policies

A precise contact zone should be determined to reduce the frequency of iatrogenic injuries.

INTRODUCTION

The radial nerve is a mixed nerve originating from the posterior bundle of the brachial plexus [**1-3].** The radial nerve is often affected in humeral fractures with radial palsy being one of the most serious complications **[2-10].** It is the most common injury of all peripheral nerves **[3, 4, 7, 11, 12].** This nerve can be injured during revision of total elbow prosthesis **[14, 15].** This is a serious complication, and the occurrence of this complication is related to the anatomical situation of the radial nerve which bypasses the humeral diaphysis on its distal part, remaining in contact with the bone [**4,7].** This anatomical proximity of the nerve-bone relationship poses problems in plate fixation of middle third humeral fractures **[13-19].** Nerve identification is a classic act for the surgeon during surgical procedures, but also during imaging or electrophysiology **[2, 3].** The objective of this study is to specify the contact zone between the lateral surface of the humerus and the radial nerve. We sought to identify the landmarks that allow us to know the area on the lateral aspect of the arm where the radial nerve crosses the humerus. We intend this study to provide precise data to avoid damage to this nerve during a surgical approach, such as percutaneous locking or osteosynthesis.

PATIENTS AND METHODS

This is an anatomical analysis of the report of the radial nerve to the lateral aspect of the humerus. We performed our study on anatomical specimens in the anatomy laboratory of the UFR of Health Sciences, University of Burgundy, France. Inclusion criteria: all anatomical parts studied in the laboratory. These are the arms on cadaveric subjects. Criteria for non-inclusion: anatomical parts not considered in the present study. The anatomical laboratory study of the radial nerve reports on the lateral aspect of the humerus was performed on 15 arms of 15 fresh subjects. Two bodies were preserved using the Thiel technique and 13 with formaldehyde. The first stage of the study consisted of taking measurements of the anatomical parts of the arms. We proceeded to finely dissect these anatomical parts **(Figure 1,2).** The radial nerve is located in its relationship to the humerus.

Figure 1. Measurements of the anatomical parts of the arms between the lateral epicondyle and the apex of the trochiter

Figure 2. Isolation of the radial nerve in the area of contact with the humerus (Djembi, Guillier, Trouilloud, Cheynel).

We dissected 15 arms: 8 men and 7 women, 9 right arms and 6 left arms. The mean age was 76.33 years (68-87). On each arm, we discovered the course of the radial nerve on the lateral aspect of the humerus, respecting as much as possible the reports between the radial nerve and the bone. 2/ We then made four measurements called "A", "B", "C" and "D", respectively, at the arms (Table 1 and Figure 2).). The normality of the sample was tested. Two individuals took the steps to establish intra- and inter-observer reproducibility. The measuring instrument used was the tape measure. With the location of the radial nerve on the lateral aspect of the humeral shaft. Similarly, the distance "D" will not be used extensively for the present study. Through these measurements, we have identified the passage zone of two peripheral nerves of the arm: the radial nerve, the subject of our study, and the circumflex nerve, the subject of a parallel study in progress. The four measures calculated are:

- The total length of the humerus, referred to as "A", is from the lateral epicondyle to the top of the trochiter
- Distance "B", also known as distance "e-x" **(Figure 3).** It is comprised between the inferior edge of the lateral epicondyle and the beginning of the crossing of the radial nerve with the lateral face of the humerus;
- Distance "C", also known as distance "e-y" (Figure 2). It is comprised between the inferior

edge of the lateral epicondyle and the distal end of the crossing of the nerve and the humerus;

- The distance "D" between the most distal zone of passage of the radial nerve on the lateral aspect of the humerus and the most distal zone of contact of the circumflex nerve on the lateral aspect of the humerus, below the trochiter (Figure 1). All data were summarized in a spreadsheet **(Table 1).**

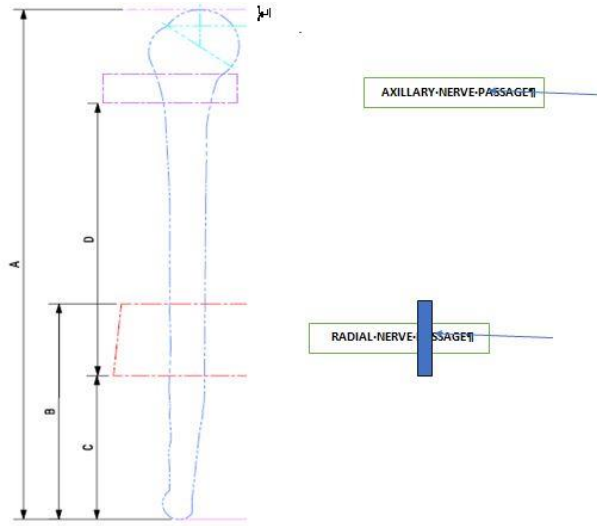

Figure 3. Measurements to identify the area of passage of two peripheral nerves in the arm : the radial nerve, subject of our study, and the axillary nerve. Total length of the humerus "A", distances "B", "C" and "D" described above (Djembi, Guillier, Trouilloud, Cheynel)

In a third step, we divided the total length of humerus "A" into 7 equal sectors **(Figures 3,4).** The free sector "SL" represents the most distal. It is located at the epicondyle. The "R" sector, also known as the "SR" sector, represents the "x-y" zone. It is the contact and passage zone of the radial nerve on the lateral surface of the humerus (**Figure 3).** It is located above the SL sector.

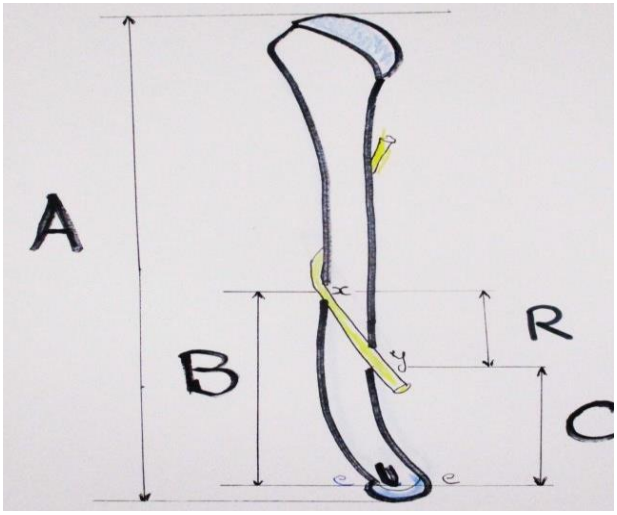

Figure 4. Schematic profile view of the lateral aspect of the humerus. Measurements: 1. total length of the humerus called "A", 2. distance "B" or distance "e-x"; distance "C" or "e-y", the sector "SR" or "x-y". (Djembi, Guillier, Trouilloud, Cheynel).

RESULTS

The average length of the humerus studied was 29 centimeters (25.5-33.5). The average "B" distance was 13 centimeters (9-14.5). Distance "C" was 7.3 centimeters (5-8). On the longest humerus, the distal limit averaged 7 cm, and the proximal average was less than 14 cm. The humerus is divided into 7 equal sectors along its length: the distal sector "SL" is free, and the radial nerve crosses the lateral face of the humerus above the free sector "SL". The SL sector represents the distal 1/7th of the total length of the humerus and is free **(Figure 5).**

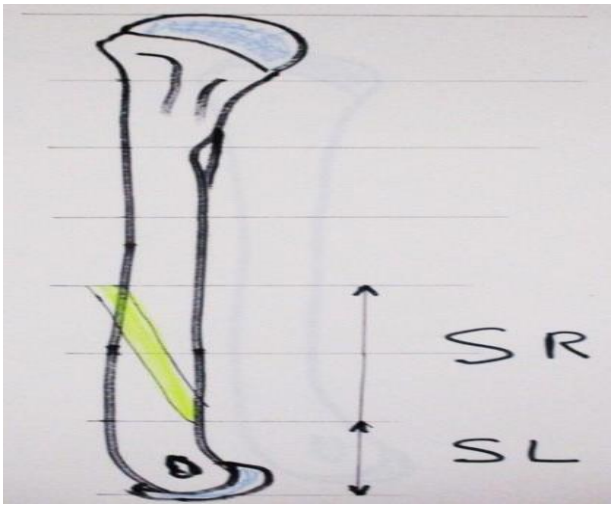

Figure 5. Schematic representation of the radial nerve passage on a side view of the lateral aspect of the humerus. The humerus is divided into 7 equal sectors along its length. The "SR" or radial sector corresponds to the radial nerve passage. The "SL" or free sector corresponds to the most distal sector. (Djembi, Guillier, Trouilloud Cheynel).

The SR sector where the radial nerve crosses is above the SL sector, representing. 2/7th of the length of the humerus **(Figure 5).**

DISCUSSION

The radial nerve is problematic in plate fixation of midline humeral fractures **[4,7,16].** Iatrogenic radial nerve injury is not uncommon in lateral approaches to humeral fractures. It is clinically manifested by a deficit in wrist and finger extension, and retropulsion-abduction of the thumb column with a defect in supination. Radial paralysis is one of the most serious complications of humeral fractures. It is the most common injury of all peripheral nerves **[3,4,13].** The identification of this nerve is therefore a classic act for the surgeon during surgical procedures, but also in imaging or electrophysiology **[1,11,14,15].** Our study suggests the delineation of a precise contact zone of the radial nerve on the lateral surface of the humerus. The interest in identifying this zone before any surgical approach reduces the frequency of radial nerve injury. This identification is a good means of orientation. It provides practitioners with accurate information for external humeral plate osteosynthesis or

for distal skin locking of Centro medullary humeral nailing. The limitation of our study is the precise location of the radial nerve, which can vary significantly from one person to another. Thus, if the humerus is divided into 7 equal sectors along its length, our data show that the crossing zone between the lateral face of the humerus and the radial nerve is located between 5 and 14.5 cm from the lateral epicondyle. In the longest humerus, the distal limit is on average 7 cm, and the proximal limit is less than 14 cm. The distal sector "SL" is free. This free distal sector SL represents the seventh (1/7th) distal of the total length of the humerus. For the SR sector, where the radial nerve crosses is above the SL sector, it represents 2/7th of the length of the humerus. Thus, the radial nerve crosses the lateral surface of the humerus above the free sector "SL". The findings of our study converge with some similar data in the literature that discuss the relationship of the surgical anatomy of the radial nerve to the humerus turn **[1, 4, 5, 6, 3, 7, 10, 11, 14, 19].**

CONCLUSION

The interest in knowing a precise contact zone of the radial nerve at the lateral surface of the humerus is an aid to the practitioner. The location of this contact zone provides reliable data to avoid iatrogenic lesions of this nerve.

Recognition of donors' corpses

The authors sincerely thank those who have donated their bodies to science so that anatomical research can be conducted. The results of this research can potentially increase the overall knowledge of mankind, which can then improve patient care. Therefore, these donors and their families deserve our deepest gratitude.

Ethical approval

The study on human anatomical parts was carried out in the anatomy laboratory of the UFR of Health Sciences in Dijon, France. The research group kindly followed the guidelines established in the laboratory by the head of the department, Professor Nicolas Cheynel. Dissection of anatomical parts. We followed the established academic and ethical guidelines in force at the Dijon anatomy laboratory.

Competing interests

"Not applicable". The authors declare that they have no conflicts of interest in this study.

Authors' contributions

- *Y.R. Djembi:* participated in the whole process of this study: elaboration of the project and protocols, data collection and analysis, dissection of anatomical parts, taking of images, elaboration of tables and figures, and writing of the manuscript.
- *R. Abiome:* participated in part of the process of this study: elaboration of the project, initial writing of the introduction.
- *Mikiela:* participated in part of the process of this study: drafting, and design of table presentation.
- *Y.E. James:* participated in part of the process of this study: drafting, critical reading and manuscript writing.
- *P. Trouilloud:* participated in the whole process of this study: elaboration of the project and protocols, data collection and analysis, dissection of anatomical parts, image taking, elaboration of tables and figures, and writing of the manuscript.
- *N. Cheynel :* participated in part of the process of this study: project development, and data analysis. In addition, as head of department, he supervised and coordinated the monitoring of the entire study process.
- *D. Guillier:* participated in part of the process of this study: data analysis, convinced the study group to submit to the journal "Surgical and Radiologic Anatomy".

Funding

"Not applicable. There are no financial or personal interests in our study.

Availability of data and materials

Declaration concerning the set of data used for the realization of this study: Design of the project and protocols, data collection and analysis, elaboration of tables and figures, taking of pictures, writing of the manuscript, etc. We used our personal belongings: didactic material (pens, pencils, erasers, drawing sheets, computers, cameras, notepads, etc.), academic books, internet connections, etc.

REFERENCES

1. Artico M., S. telera, C. Stecco, V. Macchi. Surgical anatomy of the radial nerve at the elbow. Surgical and Radiolologic Anatomy 2009 ; 31(2):101-6. Doi : 10.1007/s00276-008-0412-8. EPUB 2008 Sep 16.
2. Baqué P. Membre supérieur, le bras. In : Manuel Pratique d'Anatomie. Éllipses Éditions 2008 ; 4 : 298-299.
3. Bono CM, Grossman MG, Hochwald N, Tornetta P 3ème: Radial and axillary nerves. Anatomical considerations for humeral fixation. Clin Orthop Relat Res 2000; 373:259–264.
4. Chaudhry T, Noor S, Maher B, Bridger. The surgical anatomy of the radial nerve and the triceps fascia. J.Clin Anat. 2010 ;23(2):222-6. Doi : 10.1002/ca.20903.PMID : 20014401.
5. Cho H, Lee HY, Gil YC, Choi YR, Yang HJ. Topographic anatomy of the radial nerve and its muscular branches related to surface landmarks. Clin Anat. 2013 ;26 (7):862-869. Doi : 10.1002/ca.22115. PMID : 23090923
6. Clement H, Picher W, Tesch NP, Heidari N, Grechenig W. Anatomical basis of the risk of radial nerve damage related to the external fixation technique applied to the distal humerus. Surgical and Radiologic Anatomy 2010; 32(3): 221-224. https://doi.org/10.1007/s00276-009-0568-x
7. Cognet J.-M., T. Fabre,A. Durandeau. Paralysies radiales persistantes après fracture de la diaphyse humérale : origine, traitement et résultats. RCO 2002 : Elsevier Masson Ed. 88 (7) : 655-662. Doi : RCO-11-2002-88-7-0035- 1040-101019-ART1.
8. Drake Richard L., A. Wayne Vogl, Adam W.M. Mitchell : Bras, lésion du nerf radial. In : Grey's Anatomie, Les fondamentaux : Traduction de la 2ème édition par Fabrice Duparc. Elsevier Masson, 2018 ; 7: 386-390.2.

9. El Ayoubi L., A. Karmouta , X. Roussignol, I. Auquit-Auckbur, P.-Y. Milliez , F. Duparc : Transposition antérieure du nerf radial dans les fractures du 1/3 moyen de l'humérus : bases anatomiques et applications cliniques. Revue de Chirurgie Orthopédique et Réparatrice de L'appareil Moteur 2003, 89 (6): 537-543. Doi : RCO-10-2003-89-6-0035-1040-101019-ART8.
10. Ghazanfari Amir, Nicolas Robert, Violaine Beauthier-Landauer, Levon Doursounian, Alain-Charles Masquelet : Étude anatomique sur 20 sujets de la branche postérieure du nerf radial et de ses sites potentiels de compression. Application aux épicondylalgies latérales. Chirurgie de la Main 2014 ; 33 (6) :441-442.
11. Guse TR, Ostrum RF. The surgical anatomy of the radial nerve around the humerus.Clin Orthop Relat Res. 1995, 320:149-53. PMID : 7586819.
12. Kamina P.: Système nerveux périphérique. In : l'essentiel en anatomie. Maloine éd. 2013 ; 13 : 326-347.
13. Nachef N., V. Bariatinsky, S. Sulimovic, C. Fontaine, C. Chantelot. Predictors of radial nerve palsy recovery in humeral shaft fractures: A retrospective review of 17 patients. Orthopaedics & Traumatology: Surgery & Research 2017, 103 (2): 177-182.
14. O'Shea R, Panwar J, Chu Kwan W, Stimec J, Camp MW, Gargan M. Establishing safe areas to avoid nerve damage in the approach to the humerus in paediatric patients: a magnetic resonance imaging study. J Bone Joint Surg Am. 2019, 101(23):2101-2110. Doi : 10.2106/JBJS.19.00019. PMID : 31800423.
15. Patra A., Priti Chaudhary, Kamal Arora: Surgical anatomy of the radial nerve in the anterior compartment of the arm: relationship with the triceps aponeurosis. Surgical and Radiological Anatomy 2021, 43:689-694.
16. Testut L. : traité d'anatomie humaine, névrologie. Tome 2.Octave Doin Ed. Paris 1921, (3) 698.
17. Trost O, Trouilloud P. Innervation du membre supérieur, nerf radial. In : Introduction à l'anatomie ; Pass licence santé. Ellipses Edition 2020 ; 10: 332-334.
18. Vincelet Y., P. Journeau, D. Popkov, T. Haumont, P. Lascombes : The anatomical basis for anterior interosseous nerve palsy secondary to supracondylar humerus fractures in children. Orthopaedics & Traumatology: Surgery & Research 2013, 99 (5) : 543-547. https://doi.org/10.1016/j.rcot.2013.05.003Get rights and content
19. Waitzenegger T., P. Mansat, P. Guillon, H. Lenoir, B. Coulet, C. Lazerges, M. Chammas : Radial nerve palsy in surgical revision of total elbow arthroplasties: A study of 4 cases and anatomical study, possible aetiologies and prevention. Orthopaedics & Traumatology: Surgery & Research 2015, 101 (8): 903-907.