Anatomical Considerations Regarding the Posterior Interosseous Nerve During Posterolateral Approaches to the Proximal Part of the Radius*

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Abstract

Background: **The purpose of our study was to quantify the dimensions of a surgically safe zone along the proximal part of the radius, from the posterolateral aspect.**

Methods: **The posterolateral approach between the anconeus and the extensor carpi ulnaris was performed in thirty-two cadaveric specimens, and the posterior interosseous nerve was exposed. Forearms were measured from the radial styloid process to the radiocapitellar joint. The distance from the capitellum to the point where the posterior interosseous nerve crossed the radial shaft and the angle between the nerve and the shaft were measured with forearms in pronation and supination.**

Results: **Pronation of the forearm allowed safe exposure of at least the proximal thirty-eight millimeters of the lateral aspect of the radius, with an average proximal safe zone of 52.0 ± 7.8 millimeters. Supination decreased this proximal safe zone to as little as twenty-two millimeters and an average of 33.4 ± 5.7 millimeters. The angle formed by the posterior interosseous nerve and the radial shaft in supination averaged 47.4 ± 6.8 degrees; this decreased to 27.8 ± 6.7 degrees with pronation.**

Conclusions: **Approaching the lateral aspect of the proximal part of the radius is safest in pronation.**

The lateral[3], lateral J (Kocher J)[3], and posterolateral[3,5] approaches to the elbow are often used to expose the proximal part of the radius and the elbow joint in the management of fractures, arthritis, or contractures. While the surgical approaches and anatomy have been well described, and it is known that forearm pronation moves the posterior interosseous nerve distally along the posterolateral aspect of the radius, specific guidelines for safe exposure of the proximal portion of the radius have not been clearly delineated[1,2,4,6-13,16-19]. The posterior interosseous nerve, known to be at risk during this exposure, crosses obliquely through the surgical field from proximal and anterior to distal and posterior. Surgeons have been advised to pronate the forearm to increase the safety of this exposure by allowing the posterior interosseous nerve to lie in a more anteromedial position[5,11,16,17].

Previous studies have quantified the relationship of the posterior interosseous nerve to the proximal part of the radius from an anterior perspective[4,9,11-13]. However, there is little data describing the position of the posterior interosseous nerve with respect to the proximal part of the radius and the elbow joint from a lateral perspective. The purpose of this study was to quantify the relationship of the posterior interosseous nerve to the head and proximal part of the shaft of the radius in order to establish a safe zone for the posterolateral approach to the elbow.

Materials and Methods

Thirty-two fresh cadaveric upper extremities from individuals who were an average of seventy-seven years old at the time of death were dissected. There were twelve right and twenty left upper extremities from fourteen men and eighteen women. All forearms could be passively rotated between 80 and 90 degrees of pronation and supination, and all had full flexion and extension of the elbow. A posterolateral approach to the proximal part of the radius and the elbow joint was performed through the interval between the extensor carpi ulnaris and anconeus muscles[3]. In each limb, the posterior interosseous nerve was exposed proximally as it entered the supinator muscle and distally as it exited the supinator before arborizing into its terminal branches. The superficial layer of the supinator was incised over the posterior interosseous nerve, leaving the deep layer undisturbed.

In each specimen, the distance from the most distal aspect of the capitellar surface to the point at which the posterior interosseous nerve crossed the midpoint of the width of the radius was measured with precision calipers (number 505-637; Mitutoyo, Tokyo, Japan). Measurements were to the nearest 0.001 inch (0.0254 millimeter) and were converted to millimeters. The angle formed by the posterior interosseous nerve and the longitudinal axis of the radius was measured with a handheld goniometer. Measurements were performed with the forearm in full supination and pronation (Figs. 1-A and 1-B). The first three specimens were studied with the elbow in 0, 45, and 90 degrees of flexion to determine if elbow position had any influence on the measurements. The remaining measurements were made with the elbow in 90 degrees of flexion, a typical position of the elbow during this surgical approach[5].

To allow for the comparison of forearms of differing lengths, each radius was measured from the radiocapitellar joint to the tip of the ra-

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TABLE I
DATA ON THE THIRTY-TWO CADAVERIC SPECIMENS

	Average	Standard Deviation	Range
Age *(yrs.)*	76.9	12.9	39-96
Male/female*	14/18		
Right/left*	12/20		
Supination			
Distance from capitellum to posterior interosseous nerve *(mm)*	33.4	5.7	22-47
Angle between posterior interosseous nerve and radial shaft *(degrees)*	47.4	6.8	32-69
Pronation			
Distance from capitellum to posterior interosseous nerve *(mm)*	52.0	7.8	38-68
Angle between posterior interosseous nerve and radial shaft *(degrees)*	27.8	6.7	18-50

*The values represent the numbers of cadavera rather than the average.

dial styloid process so that safe zones could be expressed both as a percentage of the length of the radius and as an absolute distance. Averages and standard deviations were calculated with Microsoft Excel (version 7.0 [1983 to 1986]; Microsoft, Redmond, Washington).

Results

With the forearm in full supination, the posterior interosseous nerve crossed the midpoint of the long axis

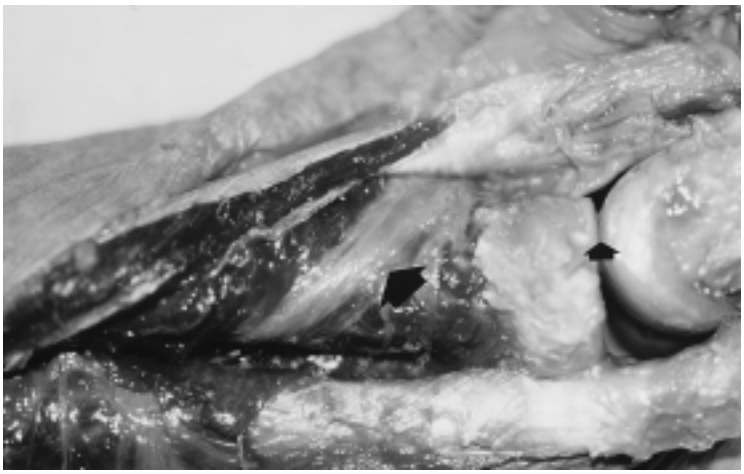

FIG. 1-A

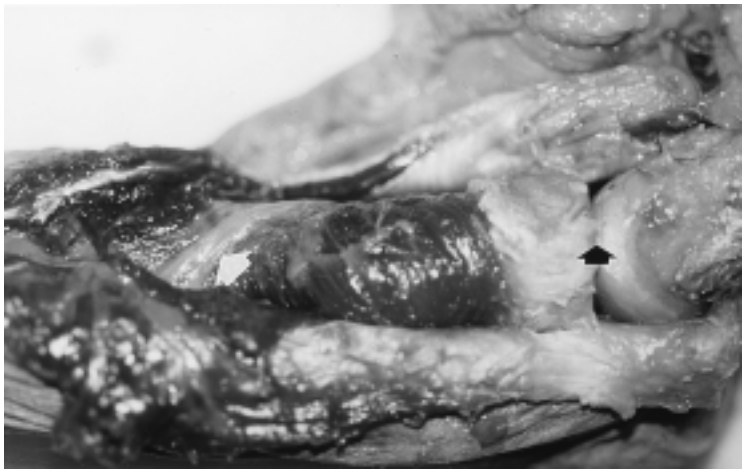

FIG. 1-B

Photographs of a cadaveric specimen of a left arm, showing the posterior interosseous nerve (large arrowhead) with the forearm in full supination (Fig. 1-A) and full pronation (Fig. 1-B). The radiocapitellar joint (small arrowhead) is proximal and to the right. The top of each photograph is anterior.

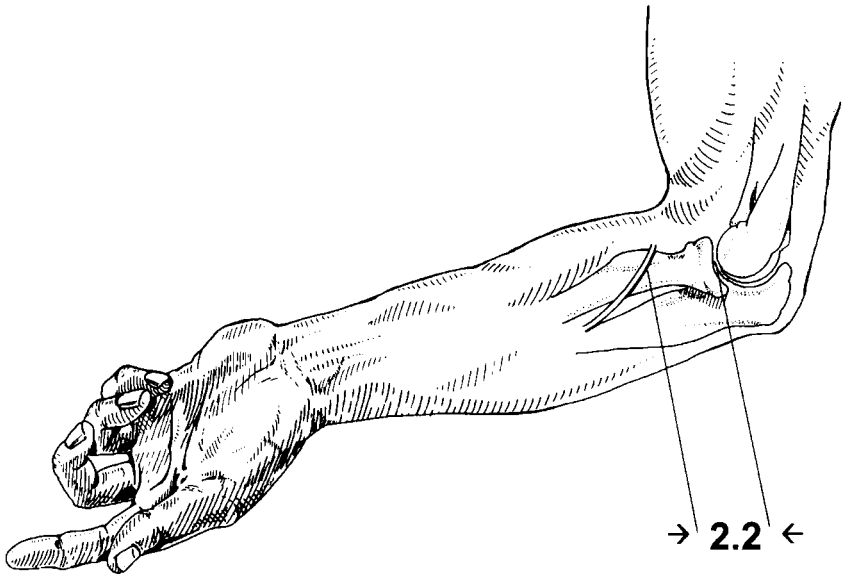

FIG. 2-A

Drawing of a forearm in supination, demonstrating the effect on the position of the posterior interosseous nerve. The minimal distance from the radiocapitellar articulation (2.2 centimeters) is shown.

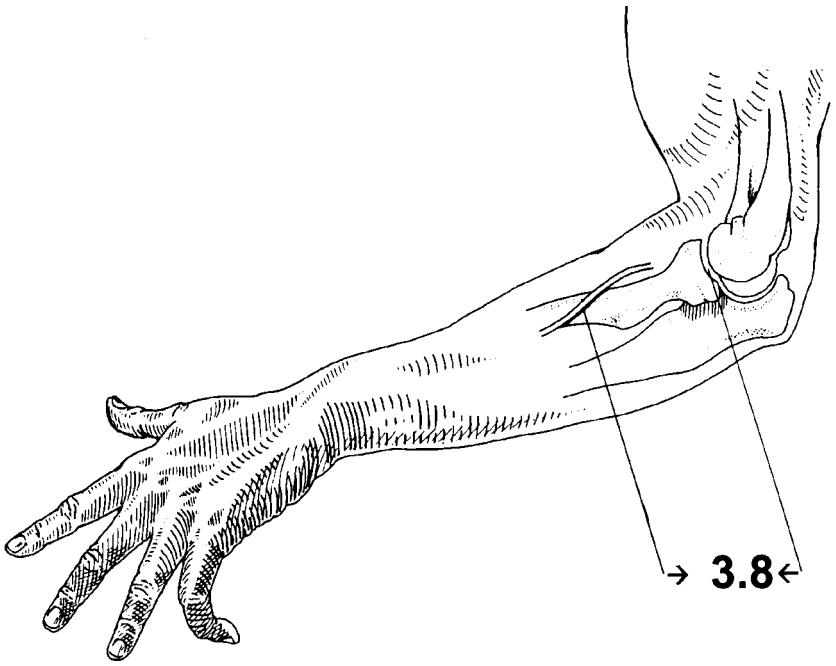

FIG. 2-B

Drawing of a forearm in pronation, demonstrating the effect on the position of the posterior interosseous nerve. The minimal distance from the radiocapitellar articulation (3.8 centimeters) is shown.

of the radius at an average (and standard deviation) of 33.4 ± 5.7 millimeters (range, twenty-two to forty-seven millimeters) from the radiocapitellar articulation. With the forearm in full pronation, this distance increased to an average of 52.0 ± 7.8 millimeters (range, thirty-eight to sixty-eight millimeters). Flexion and extension of the elbow had no effect on these distances. The average radial length was 229.2 ± 14.7 millimeters (range, 208 to 259 millimeters). An average of 14.5 ± 2.0 percent (range, 10 to 19 percent) of the radius could be safely exposed proximally with the forearm in supination, and this average increased to 22.7 ± 3.0 percent (range, 17 to 27 percent) with the forearm in pronation. The angle formed by the posterior interosseous nerve and the long axis of the radius decreased from an average of 47.4 ± 6.8 degrees (range, 32 to 69 degrees) with the forearm in supination to 27.8 ± 6.7 degrees (range, 18 to 50 degrees) with the forearm in pronation (Table I). Thus, the posterior interosseous nerve becomes more parallel to the long axis of the radius with forearm pronation.

FIG. 3-A

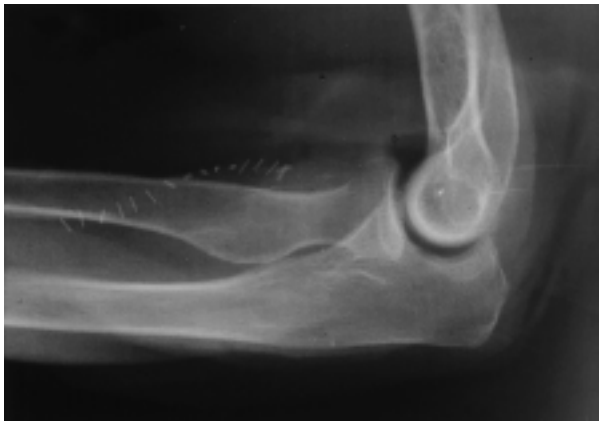

FIG. 3-B

Lateral radiographs of a cadaveric left arm in supination (Fig. 3-A) and pronation (Fig. 3-B) with the course of the posterior interosseous nerve delineated with radiopaque markers.

Discussion

The posterior interosseous nerve moves medially as much as one centimeter with forearm pronation[8,15,16]. This effect occurs in the coronal plane and is more useful when a surgeon is approaching the proximal part of the radius anteriorly. When a posterolateral approach to the elbow is performed, pronation of the forearm rotates the supinator and extensor muscles from a posterior to a relatively more anterior position, placing the posterior interosseous nerve more parallel to the radial shaft. By assuming this more parallel course, the posterior interosseous nerve is less likely to be injured during longitudinal sharp or blunt dissection (Figs. 2-A through 3-B).

Exposure of the head, neck, and proximal part of the shaft of the radius is frequently necessary when fractures are treated with open reduction and internal fixation[14]. The commonly used three-hole mini T-plate (Synthes, Paoli, Pennsylvania) is thirty-two millimeters in length. Proximal radial exposure with the forearm in pronation would have allowed safe placement of this device in all of the cadavera in the present study. However, forearm supination would have placed the posterior interosseous nerve at risk in most of our specimens.

Osseous landmarks can be distorted when the radial head is fractured or dislocated. Since the posterolateral approach to the elbow is often used to treat these injuries, our measurements were based on the capitellar surface rather than on the radial head. Provided that the capitellum and the lateral column of the distal part of the humerus are intact, it is possible to accurately estimate the distance between the point at which the posterior interosseous nerve crosses the radial shaft and the most distal portion of the capitellum without relying on the radial head.

It is our belief that the posterior interosseous nerve should be formally exposed and protected in any setting (trauma, posttraumatic reconstruction, tumor excision, and so on) in which the surgical dissection must be performed in proximity to the nerve as predicted by our measurements. The posterior interosseous nerve can be identified distally as it exits from beneath the supinator muscle, between its superficial and deep portions, and traced proximally back to the surgical zone to augment safety[10,11]. The posterior interosseous nerve has been shown to enter and exit between the superficial and deep layers of the supinator at an average of 2.5 ± 0.3 centimeters and 6.0 ± 0.9 centimeters from the radiocapitellar joint, respectively[11].

Our measurements should assist surgeons in operating more safely in the area of the proximal part of the radius, especially during complex trauma or revision surgery in which anatomical landmarks may not be as easily visualized.

References

1. **Capener, N.:** The vulnerability of the posterior interosseous nerve of the forearm. A case report and an anatomical study. *J. Bone and Joint Surg.,* 48-B(4): 770-773, 1966.
2. **Carstam, N.:** Operative treatment of fractures of the head and neck of the radius. *Acta Orthop. Scandinavica,* 19: 502-526, 1950.
3. **Crenshaw, A. H.:** Surgical techniques and approaches. In *Campbell's Operative Orthopaedics,* edited by S. T. Canale. Ed. 9, pp. 126-130. St. Louis, Mosby, 1998.
4. **Fuss, F. K.,** and **Wurzl, G. H.:** Radial nerve entrapment at the elbow: surgical anatomy. *J. Hand Surg.,* 16A: 742-747, 1991.
5. **Hoppenfeld, S.,** and **deBoer, P.:** *Surgical Exposures in Orthopaedics: The Anatomic Approach.* Ed. 2, pp. 103-106. Philadelphia, J. B. Lippincott, 1994.
6. **Hotchkiss, R. N.:** Displaced fractures of the radial head: internal fixation or excision? *J. Am. Acad. Orthop. Surgeons,* 5: 1-10, 1997.
7. **Jupiter, J. B.,** and **Mehne, D. K.:** Trauma to the adult elbow and fractures of the distal humerus. In *Skeletal Trauma. Fractures, Dislocations, Ligamentous Injuries,* edited by B. D. Browner, J. B. Jupiter, A. M. Levine, and P. G. Trafton. Vol. 1, pp. 1125-1176. Philadelphia, W. B. Saunders, 1992.
8. **Kaplan, E. B.:** Surgical approach to the proximal end of the radius and its use in fractures of the head and neck of the radius. *J. Bone and Joint Surg.,* 23: 86-92, 1941.

9. **Low, C. K.; Chew, J. T.;** and **Mitra, A. K.:** A surgical approach to the posterior interosseous branch of the radial nerve through the brachioradialis — a cadaveric study. *Singapore Med. J.,* 35: 394-396, 1994.
10. **Mayer, J. H., Jr.,** and **Mayfield, F. H.:** Surgery of the posterior interosseous branch of the radial nerve. Analysis of 58 cases. *Surg., Gynec. and Obstet.,* 84: 979-982, 1947.
11. **Mekhail, A. O.; Ebraheim, N. A.; Jackson, W. T.;** and **Yeasting, R. A.:** Vulnerability of the posterior interosseous nerve during proximal radius exposures. *Clin. Orthop.,* 315: 199-208, 1995.
12. **Mekhail, A. O.; Ebraheim, N. A.; Jackson, W. T.;** and **Yeasting, R. A.:** Anatomic considerations for the anterior exposure of the proximal portion of the radius. *J. Hand Surg.,* 21A: 794-801, 1996.
13. **Prasartritha, T.; Liupolvanish, P.;** and **Rojanakit, A.:** A study of the posterior interosseous nerve (PIN) and the radial tunnel in 30 Thai cadavers. *J. Hand Surg.,* 18A: 107-112, 1993.
14. **Sanders, R. A.,** and **French, H. G.:** Open reduction and internal fixation of comminuted radial head fractures. *Am. J. Sports Med.,* 14: 130-135, 1986.
15. **Spinner, M.:** *Injuries to the Major Branches of Peripheral Nerves of the Forearm,* pp. 28-32. Philadelphia, W. B. Saunders, 1972.
16. **Strachan, J. C. H.,** and **Ellis, B. W.:** Vulnerability of the posterior interosseous nerve during radial head resection. *J. Bone and Joint Surg.,* 53-B(2): 320-323, 1971.
17. **Strauch, R. J.; Rosenwasser, M. P.;** and **Glazer, P. A.:** Surgical exposure of the dorsal proximal third of the radius: how vulnerable is the posterior interosseous nerve? *J. Shoulder and Elbow Surg.,* 5: 342-346, 1996.
18. **Wadsworth, T. G.:** *The Elbow,* pp. 24-27. New York, Churchill Livingstone, 1982.
19. **Young, C.; Hudson, A.;** and **Richards, R.:** Operative treatment of palsy of the posterior interosseous nerve of the forearm. *J. Bone and Joint Surg.,* 72-A: 1215-1219, Sept. 1990.