# Investigating Orthogonal Radiography in the Diagnosis of Radial Head Fractures

Dan L Hobbs, MSRS, R.T.(R)(CT)(MR)
Wendy Mickelsen, MHE, R.T.(R)(M)
Christopher Ira Wertz, MSRS, R.T.(R)
Cauleen Stradling, BSRS, R.T.(R)(M)
Melissa Boyce, BSRS, R.T.(R)
Nannette Chandler, BSRS, R.T.(R)
Devin Schneyder, R.T.(R)
Casey Jackman, MVH

Fractures of the radial head constitute approximately one-third of all elbow fractures.[1] The mechanism of injury frequently involves a fall on an outstretched hand or direct trauma to the joint. Most patients will resist movement of the injured arm,[2,3] which presents a hardship to the radiographer and patient especially because the ulna can obscure the radial head, traditionally visualized with an external oblique position that is challenging for patients with these types of injuries. The literature discusses alternative methods for these patients, including the Coyle method that uses a 45° cephalic tube tilt to separate the ulna from the radius.[4-6] If the elbow is in flexion, this method offers a distinct, though distorted, view of the joint and can be used with patients who cannot extend their arm. Variations of the Coyle method can be performed in recumbent and sitting positions.[2,4-8] Although the images are distorted because the image receptor does not intercept the central ray (CR) at a right angle, the Coyle method and its variations provide alternative views of the radial head without the superimposition of the ulna.

In contrast, when the trauma patient presents with the arm extended, the external oblique is difficult to obtain. Pain, effusion in the elbow, and tenderness over the radial head are typical of radial head injuries.[8] Some patients cannot tolerate the leaning required to put the interepicondylar plane in a 45° oblique position for the external oblique. Severely injured patients cannot be moved into this position; elderly patients also often have difficulty assuming the position. If the patient's elbow is extended, the Coyle method offers no advantage. If the patient is recumbent with the arm extended, the entire body sometimes can be rotated into a posterior oblique position, and the arm naturally rotates externally. Recumbent positions make it easier to obtain the external oblique position with a vertical beam. However, when the patient is sitting, the throbbing typically associated with the injury makes it difficult to lean laterally and is awkward and painful for the patient. Regardless, many patients present in the sitting or upright position, and when this happens, an orthogonal approach should be considered.

The term *orthogonal* means right angle. "Two views 90° from each other" is a mantra of educators to students; it should always be done. Orthogonal comes from the Greek *ortho* meaning right and *gon* meaning angled.[9] Thus, the investigation performed for this article shadows the Greek definition of using right angles, but for a single oblique position rather than a 2-view minimum approach. For this study, the orthogonal method employed a 45° CR angle and a 45° tilt of the image receptor, resulting in right angle radiography of the elbow. The traditional anteroposterior and lateral projections still would be performed, but the right angle for the oblique position would be obtained by a CR/image receptor tilt. With this method, the elbow joint remains in the supinated position, and the resultant image is analogous to the traditional approach. It could be compared to C-arm methodology (ie, the body part remains in the same orientation, and the technologist captures a unique view by stopping the rotation of the C-arm as it rotates around the body part). However, the technologist

would use a stationary tube and make the exposure at the stop.

The hypothesis alleged that by applying an orthogonal methodology to the elbow joint, a position not discussed in traditional textbooks could be obtained with any standard x-ray tube. Likewise, the advent of wireless detectors and mobile lateral cassette holders would make the external oblique position easier to acquire without rotating the patient's arm. An additional postulation was that the position also could be performed by using a 45° rotating upright Bucky with a perpendicular CR angle. The assumption is that if the CR/image receptor is placed at a 45° angle, the resulting image will be identical to radiographs obtained with the traditional external oblique position.

## Laboratory Testing

The 45° CR/image receptor orthogonal method originated in a laboratory setting at Idaho State University. An elbow phantom was placed on sponges to simulate the position. Caution was used to ensure the interepicondylar plane was parallel to the tabletop. A 45° sponge supported the image receptor, and the tube was tilted 45° so the CR was perpendicular to the image receptor (see **Figure 1**).

The setup for the traditional method included rotating the phantom so the interepicondylar plane was at a 45° angle to the image receptor. This position provided an external oblique without needing to angle the tube. The resultant image was used as a control image to compare to the orthogonal method.

The CR must enter the medial side of the arm for separation of the radial head to occur. If in doubt, one can deduce that the traditional external oblique raises the medial side of the arm when the patient leans laterally. Therefore, the CR enters medially and exits the downside or lateral side of the arm when performed by way of a vertical beam (see **Figure 2**). This same logic holds true with the angled approach. Although the arm remains supinated, the CR enters the medial side and exits the lateral side of the joint.

Students from 4 different lab sections at Idaho State University performed both the orthogonal and routine methods to test the hypothesis that the radiographs would look the same. Each lab section produced a series of radiographs and compared the images.


**Figure 1.** *To demonstrate the 45° central ray (CR)/image receptor (IR) orthogonal positioning, both the x-ray tube and the image receptor are tilted. The elbow phantom is in a supinated position, meaning the interepicondylar plane is parallel to the tabletop and is not rotated laterally. The CR enters the medial side of the arm phantom.*

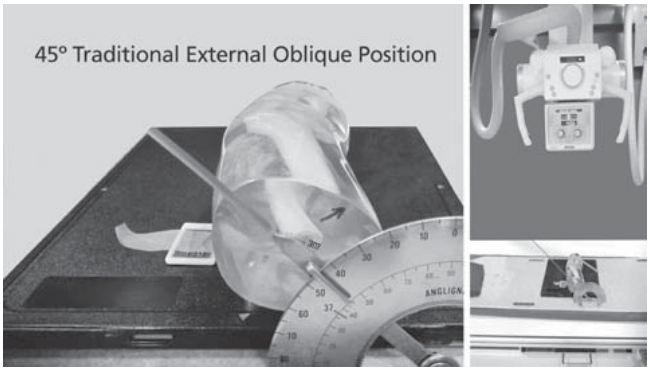


**Figure 2.** *This setup demonstrates the traditional method of performing this study. The phantom was rotated laterally so the interepicondylar plane was at a 45° angle to the image receptor. The resulting image was used as a control image for comparison purposes.*

Although some images were not identical, investigation revealed that either the phantom was not correctly oriented or the CR angle of the tube or image receptor was incorrect. When either problem occurred, the images were repeated immediately by the same individuals. After repeating with proper orientation or angling, each lab section demonstrated almost identical images. The results for all labs found no major differences in the outcome when comparing both methods (see **Figure 3**).

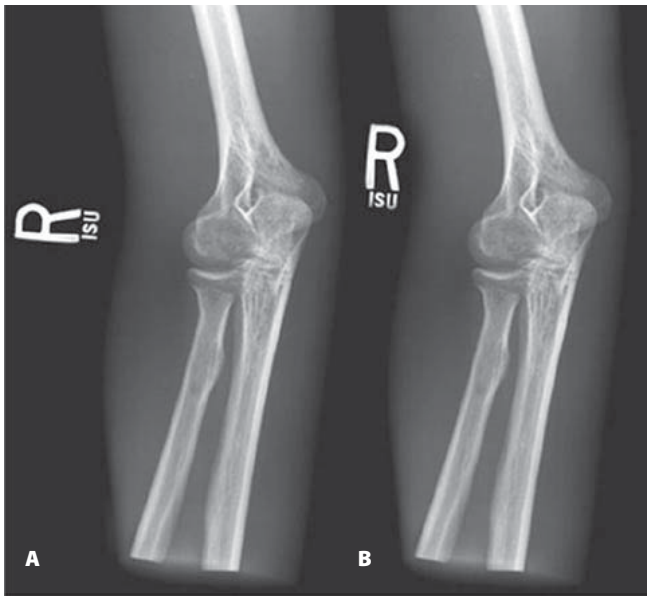


**Figure 3.** *These phantom images demonstrate the likeness of the 2 methods performed in the laboratory setting. A. Exam performed with the traditional method was used as the control. B. Exam was performed with the 45° CR/image receptor orthogonal approach. Both phantom images demonstrate adequate separation of the radial head from the ulna and are identical.*

## Clinical Trial

After experimentation and review of the images in the laboratory, it was proposed that the orthogonal method be performed in a clinical setting. The Institutional Review Board at a local hospital agreed to participate in the study. After demonstrating the new position to technologists, the technologists evaluated the mechanism of injury and presentation of the patient before determining whether the orthogonal position would be attempted. Over a period of 6 weeks, 25 orthogonal elbow exams were performed on outpatients aged 18-50 years. All patients suffered trauma, with falling being the most common complaint. The 45° CR/image receptor orthogonal oblique was performed in place of the traditional external oblique (see **Figure 4**). The setup was similar to the lab setting; however, a floor-mounted tube was used to obtain the position, which logistically took additional time to maneuver into the correct position.

One patient fell 8 feet from a ladder and suffered a radial head fracture (see **Figure 5**). He had difficulty

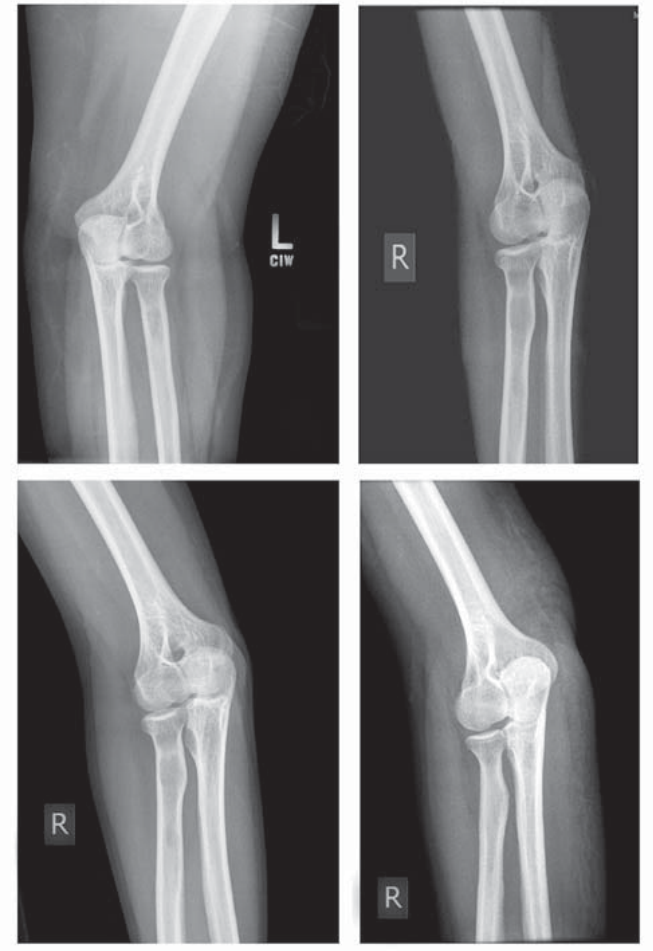


**Figure 4.** *Examples of the 45° CR/image receptor orthogonal approach clearly demonstrate separation of the radial head without distortion.*

extending his arm fully; however, obtaining radiographs using the orthogonal approach was simple. All images were of sufficient quality and nearly identical to radiographs typically taken with the traditional approach. The technologists remarked that this procedure was easier than they first envisioned. Most patients were easily moved into this new position.

Radiologists were blinded to the change of procedure (ie, they were unaware the study was taking place). It is interesting to note that the radiologists did not comment on positioning in any exam report and that no objections were noted in the radiologists' interpretation. Most radiographs demonstrated good separation of the radial head from the ulna. Comparatively, the radiographs had


**Figure 5.** *Image obtained using a 45° CR/image receptor orthogonal approach clearly demonstrates a radial head fracture. The patient could not extend his arm completely, but the efficacy of the exam remained intact.*


**Figure 6.** *A radiography student model demonstrates the 45° CR/image receptor orthogonal position. A. Wireless detector placed in a mobile lateral cassette holder. B. The model demonstrates the position in a rotating upright Bucky.*

the same appearance as the external oblique performed with the traditional rotational method.[4-6]

The orthogonal position also has been tried in a clinical setting that uses flat panel detectors. In this setting, the position is easier to obtain because lateral imaging plate holders and upright detectors can be manipulated into many positions (see **Figure 6**). Moreover, departments with tilting upright Bucky trays can more readily position patients this way. The position also can be done with the patient standing.

## Discussion

Radial head and neck fractures account for an estimated 25% to 44% of all elbow fractures and 1.7% to 5.4% of all fractures in adults; 85% of radial head fractures occur in patients between 20 and 60 years old.[10-13] Thus, great care should be taken to avoid missing radial head and neck fractures. The research in this study shows that technologists can offer similar results with orthogonal and traditional methods. A 45° CR/image receptor orthogonal approach is innovative and easily can be added to a radiographer's repertoire. The Coyle method uses a single 45° angle and should be used when the situation warrants.

A disadvantage of the orthogonal method is that it cannot be used when the joint is flexed. However, the radial head fracture discussed in the clinical trial section shows that the orthogonal approach can be used in a partially flexed joint. Another disadvantage is related to the type of equipment used when performing the exam. Technologists from departments with floor-mounted tube stands found this position cumbersome and more time consuming than the traditional method. Likewise, technologists sometimes found it problematic to find sponges and accessory items needed to support the arm.

Future studies could investigate this orthogonal approach with other exams. For example, an oblique of the hand, wrist, and ankle should render the same

results by tilting both the CR and the image receptor while the patient maintains a fixed position. In addition, studies using lateral detector holders and upright Bucky trays could be used to expose a variety of recumbent patient positions. Futhermore, the orthogonal approach could be investigated with the Clements-Nakayama method of the proximal hip and axillary views of the shoulder. Positioning textbooks might include CR angles, required projections, and the direction of the CR needed to obtain the desired result. Similar projections might be a good addition to a trauma chapter. At the least, textbooks should demonstrate positions like this to stimulate critical thinking. Regardless, wireless detectors and portable detector holders will lead to innovative and viable approaches to traditional positioning methods.

## Conclusion

The 45° CR/image receptor orthogonal approach is easy to perform and offers quality images. Technology is rapidly changing, and innovative approaches to traditional methods can alleviate awkward and painful maneuvers for the patient without disrupting the integrity of the study. Thinking intuitively can alleviate painful positions and provide nontraditional but similar results. This orthogonal approach can be adapted at most clinical sites. Technologists should be encouraged to think of innovative ways to accomplish the same tasks while improving patient satisfaction and comfort.

*Dan L Hobbs, MSRS, R.T.(R)(CT)(MR), is a radiographic science associate professor for Idaho State University in Pocatello. He can be contacted at hobbsdan@isu.edu for more information regarding the content of this article.*

*Wendy Mickelsen, MHE, R.T.(R)(M), is an assistant professor for the Idaho State University radiographic science program in Pocatello.*

*Christopher Ira Wertz, MSRS, R.T.(R), is an adjunct faculty member for the Idaho State University radiographic science program in Pocatello.*

*Cauleen Stradling, BSRS, R.T.(R)(M); Melissa Boyce, BSRS, R.T.(R); Nannette Chandler, BSRS, R.T.(R); and Devin Schneyder, R.T.(R), are radiographers for the Mountain View Hospital radiology department in Idaho Falls.*

*Casey Jackman, MVH, is the director of ancillary services for Mountain View Hospital in Idaho Falls.*

## References

1. Pappas N, Bernstein J. Fractures in brief: radial head fractures. *Clin Orthrop Relat Res*. 2010;468(3):914-916.
2. Hobbs DL. Fat pad signs in elbow trauma. *Radiol Technol*. 2005;77(2):93-96.
3. Ramponi DR, Kaufmann JA. Elbow injuries and fractures. *Adv Emer Nur J*. 2012;34(2):99-109.
4. Ballinger PW, Frank ED. *Merrill's Atlas of Radiographic Positions and Radiologic Procedures*. 11th ed. St Louis, MO: Mosby-Year Book Inc; 2012:160-165.
5. Bontrager KW, Lampignano JP. *Textbook Radiographic Position and Related Anatomy*. 7th ed. St Louis, MO: Mosby-Year Book Inc; 2010:168.
6. Greathouse JS. *Radiographic Positioning & Procedures: A Comprehensive Approach*. Clifton Park, NY: Cengage Learning; 2006:166.
7. Harris JH, Harris WH. *The Radiology of Emergency Medicine*. 4th ed. Philadelphia, PA: Lippincott Williams & Wilkins Co; 2000:213.
8. Wheeless CR III. Radial head frx. Wheeless' Textbook of Orthopaedics website. www.wheelessonline.com/ortho/radial_head_frx. Accessed January 30, 2013.
9. Definition orthogonal. Search Storage website. http://searchstorage.techtarget.com/definition/orthogonal. Accessed January 31, 2013.
10. Karlsson MK, Herbertsson P, Nordqvist A, Besjakov J, Josefsson PO, Hasserius R. Comminuted fractures of the radial head. *Acta Orthop*. 2010;81(2):224-227.
11. Kaas L, van Riet RP, Vroemen JP, Eygendaal D. The incidence of associated fractures of the upper limb in fractures of the radial head. *Strategies Trauma Limb Reconstr*. 2008:3(2):71-74.
12. Morrey BF. Radial head fracture. In: *The Elbow and Its Disorders*. 3rd ed. Philadelphia, PA: WB Saunders; 2000:341-364.
13. Baker CL, Plancher KD, eds. *Operative Treatment of Elbow Injuries*. New York, NY: Springer; 2002:207-214.