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ORIGINAL ARTICLE

The Axillary View Typically Does Not Contribute to Decision Making in Care for Proximal Humeral Fractures

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Abstract *Background:* Convention dictates that an axillary view be obtained when evaluating proximal humerus fractures (PHF). However, the axillary view is frequently omitted because of pain and technical considerations. Furthermore, its diagnostic utility is unclear in this setting. *Questions/Purposes:* The purpose of this study was to (1) determine the rate of obtaining an adequate axillary X-ray and complete shoulder series at a level I trauma center, (2) understand the cost of ordering and attempting an axillary radiograph, and (3) determine if axillary radiographs influence the management of PHF. *Patients and Methods:* PHF treated between 2009 and 2011 that were ordered for an AP, scapular Y, and axillary view was identified. The types of radiographs actually obtained were recorded. The cost of obtaining three views and a single view of the shoulder with X-ray was determined. Lastly, three surgeons reviewed 42 PHF, both with and without an axillary view (AV), and treatment recommendations were compared. *Results:* 30% of PHF in this series had an adequate axillary view, and 14% received a complete trauma series. No factors could be identified that were associated with successfully obtaining an axillary view. Reviewers demonstrated substantial intraobserver reliability (κ=0.759–0.808) regarding treatment recommendations for PHF with and without the axillary view. The addition of the AV had minimal influence on treatment recommendations. *Conclusion:* Considering that the axillary view for PHF is painful, labor-intensive, costly, and does not appear to provide additional diagnostic value, orthopedic surgeons can consider foregoing the use of the axillary view when evaluating and treating PHF, particularly if other advanced imaging is utilized.

Keywords axillary view · radiograph · proximal humerus fracture

Level of Evidence: Diagnostic, Study Level III.

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Introduction

Fractures of the proximal humerus are among the most common fractures encountered in clinical practice, particularly in patients with osteoporosis [3, 2, 9]. Classic teaching mandates that these injuries undergo a thorough and appropriate plain radiographic evaluation by means of the shoulder trauma series. This series of radiographs is at a minimum comprised of a true AP, scapular Y and axillary view [11]. The axillary view provides an orthogonal view to the glenohumeral joint and is reported to best identify glenohumeral instability or bony abnormalities of the glenoid. However, the axillary view is not without its problems. First and foremost, it can be difficult to obtain, particularly following an acute injury. Patients requiring shoulder imaging in the emergency room are more than likely experiencing significant shoulder pain, or may have other injuries as well which compromise patient cooperation. All of these factors represent real barriers to obtaining an adequate axillary view of the shoulder, and as a result, is frequently omitted even when explicitly ordered. Additionally, the actual

diagnostic value of the axillary view is debatable [8, 10, 6, 12] particularly with respect to the evaluation of fractures of the proximal humerus [13, 7]. Furthermore, proximal humerus fractures are increasingly being imaged through the use of computed tomography [1] which offers a superior multiplanar visualization compared to a single two-dimensional projection.

At our institution, all patients seen and evaluated in the emergency room with a suspected shoulder injury, specifically a proximal humerus fracture, are ordered for a shoulder trauma series. Anecdotally, we have noted that the axillary view is often omitted, despite being explicitly ordered. This led us to a number of questions. How often are adequate axillary radiographs being taken in our emergency room? How much time and money is wasted in an effort to obtain an axillary view? And most importantly, does an axillary radiograph actually affect clinical decision making?

The purpose of this study was threefold. We primarily aimed to assess in patients with proximal humerus fractures the true rate of obtaining an adequate axillary X-ray and complete shoulder trauma series in the emergency room at a level I trauma center and identify those factors associated with successful completion. Secondly, we aimed to clarify the health care cost of ordering and attempting an axillary radiograph in the emergency room. Finally, we wished to determine if axillary radiographs influence clinical decision making and the management of proximal humerus fractures. The study hypothesis were as follows: (1) Axillary radiographs and complete shoulder trauma series are taken at a low rate.; (2) Axillary radiographs result in significant costs to patients and the health care system at large.; and (3) Axillary radiographs do not influence treatment recommendations when evaluating proximal humerus fractures.

Patients and Methods

The emergency department billing registry at a level I trauma center was queried from January 1, 2009 until June 1, 2011 using the ICD-9 codes consistent with proximal humerus fracture (812.0-812.09, 812.10-812.19). The radiographs for each case were then reviewed individually to confirm the presence of a proximal humerus fracture; those without a proximal humerus fracture or not ordered for a shoulder trauma series were excluded. For each included case, the hospital's picture archiving and communication system (PACS) was utilized to record which radiographic views of the shoulder were obtained. If an axillary view was obtained, it was noted if it was taken at the time of the other initial shoulder radiographs or if it required a repeat trip to the radiology suite. Also, the adequacy of the axillary view was noted, defined as being able to clearly visualize the humeral head and entire glenohumeral joint. Each fracture was classified according to the Neer and the Arbeitsgemeinschaft für Osteosynthesefragen (AO) systems. For each case, other recorded information included patient age and sex, presence of ipsilateral upper extremity injury, and dislocation was obtained. In order to understand the cost of ordering and attempting an axillary view X-ray, emergency department billing information was referenced to determine the amount billed to a patient for a single view of the shoulder, as well as three views of the shoulder.

In order to assess the diagnostic importance of the axillary view, a sub analysis of all fractures with an adequately performed axillary view was conducted ($n=42$). A fellowship-trained trauma surgeon (DGL), a fellowship-trained shoulder surgeon (JSD), and a general orthopedist without subspecialty training (MBB) viewed all cases first without including the axillary view and were asked to provide a recommendation for management. The only three management choices available to the reviewers were operative treatment, nonoperative treatment, or obtain a CT scan in order to determine appropriate care. This represents a novel survey devised by the authors specifically for this investigation and has not been previously validated. The cases were then randomized and viewed again, this time including the axillary view. Again, all reviewers then provided a management recommendation (operate, treat nonoperatively, or obtain a CT scan). The entire set of radiographs, including those without and with an axillary view, was reviewed on a total of three separate occasions separated by a minimum of 2 weeks to provide for a more robust data set for analysis. An intraobserver reliability analysis was performed for each reviewer when considering only radiographs without an axillary view, and the same calculation was performed when the axillary view was included. In this way, the internal consistency of each reviewer was determined. In order to determine whether the axillary view had any influence on treatment recommendations for each reviewer, a kappa value was calculated in an inter-rater approach by comparing each reviewer's treatment recommendations without an axillary view to the recommendations with the use of an axillary view.

A statistical analysis was performed to identify factors associated with successfully obtaining an axillary view using Fisher's exact test for categorical variables and independent sample t test for continuous variables.

Results

One hundred seventy eight possible proximal humerus fractures were identified from the initial ICD-9 query; of these, 142 represented actual proximal humerus fractures based upon radiographic review. Of these 142 proximal humerus fractures in which a standard trauma series of the shoulder was ordered, 51 received an axillary view (36%). 21 of the 51 axillary radiographs (41%) were not obtained with the first set of images and required that the patient be sent back to the radiology suite with a separate order. Of the 51 axillary X-rays, 9 were inadequate; thus, 42 of 142 (30%) proximal humerus fractures in this cohort received an adequate axillary view. Furthermore, 20 of the 142 fractures (14%) received a complete and acceptable trauma series of the shoulder including, at a minimum, an AP, scapular Y, and axillary view.

When considering variables associated with obtaining an adequate trauma series of the shoulder in patients with

a proximal humerus fracture, only an external rotation radiograph was found to be predictive (p=0.037). Neer classification (0.385), AO classification (0.548), age (0.290), gender (0.271), presence of an ipsilateral upper extremity injury (0.999), and dislocation (0.999) were not found to be indicators for obtaining a complete trauma series (Table 1). With regard to successfully obtaining an axillary radiograph, Neer classification (0.283), AO classification (0.446), age (0.760), gender (0.299), and ipsilateral injury (0.670) were not found to be indicators. However, patients who had a dislocation were more significantly more likely to have had an adequate axillary X-ray (0.008) (Table 2).

A review of hospital billing practices at our institution revealed that the charged amount for three views of the shoulder (i.e., trauma series) is $293.58. The charge for a single view of the shoulder is $257.32.

Each reviewer demonstrated substantial to almost perfect intraobserver reliability and internal consistency regarding treatment recommendations when considering only images without the axillary view (kappa 0.79–0.876, Table 3) and the images inclusive of the axillary view (kappa 0.784–0.847, Table 4). An inter-rater type analysis, comparing each individual reviewer's treatment recommendations without an axillary view to their own recommendations with the use of an axillary view, demonstrated substantial to almost perfect agreement (kappa 0.759–0.808, Table 5). In this way, the addition of the axillary view was found to have little to no influence on treatment recommendations for these proximal humerus fracture cases.

Discussion

In this study, when considering only patients with a proximal humerus fracture, we sought to determine the frequency of a successful axillary view completion and whether any factors were associated with a successful completion. Furthermore, we sought to understand the costs associated with obtaining an axillary view and lastly determine if the axillary view had any influence on the clinical decision making and management of proximal humerus fractures. We found that in our institution, despite being ordered explicitly, an adequate axillary view was taken in only 30% of patients and even fewer (14%) received an adequate and complete trauma series of the shoulder. Fracture pattern and other variables, besides the presence of a glenohumeral dislocation, were not predictive of a successful axillary view completion. Glenohumeral dislocation was found to be associated with an axillary view; this is not surprising since this view was most commonly used as a means of confirming glenohumeral stability in the emergency room by the consulting orthopedist. On an individual basis, sending a patient back to the radiology suite for an axillary view increased the cost billed to patients at our institution by $257.32. Lastly, we found that an axillary X-ray was of little to no utility as it did not provide any additional information sufficient to change treatment recommendations for proximal humerus fractures.

There are clearly limitations to this investigation. The data regarding the rate of successful axillary view radiographs was performed in a retrospective fashion. Also, although all X-rays were ordered as a trauma series with three views of the

Table 1 Comparison of groups in the study cohort based upon completion of a complete trauma series

Complete trauma series?	No			Yes			
	Number	Mean or %	SD	Number	Mean or %	SD	p value
Total N	122			20			
Female sex	34	27.9%		8	40.0%		0.271
Age	122	67.34	16.68	20	71.55	14.80	0.290
Radiograph							
AP	121	99.2%		20	100.0%		0.999
IR	105	86.1%		19	95.0%		0.469
ER	3	2.5%		3	15.0%		0.037
Scap Y	110	90.2%		20	100.0%		0.217
Neer classification							
1	60	49.2%		12	60.0%		0.385
2	36	29.5%		7	35.0%		
3	21	17.2%		1	5.0%		
4	5	4.1%		0	0.0%		
AO classification							
A1	38	31.1%		6	31.0%		0.548
A2	46	37.7%		12	40.8%		
A3	10	8.2%		1	7.7%		
B1	15	12.3%		0	10.6%		
B2	3	2.5%		0	2.1%		
C1	2	1.6%		0	1.4%		
C2	6	4.9%		1	4.9%		
C3	2	1.6%		0	1.4%		
Ipsilateral UE fx	5	4.1%		1	5.0%		0.999
Dislocation	9	7.4%		1	5.0%		0.999

SD standard deviation, *N* number, *AP* anteroposterior, *IR* internal rotation, *ER* external rotation, *Scap Y* scapular Y, *UE* upper extremity

Table 2 Comparison of groups in the study cohort based upon completion of an adequate axillary view

Axillary X-ray?	No			Yes			
	Number	Mean or %	SD	Number	Mean or %	SD	*p* value
Total N	100			42			
Female sex	27	27.0%		15	35.7%		0.299
Age	100	68.23	15.32	42	67.21	19.04	0.760
Radiograph							
AP	99	99.0%		42	100.0%		0.999
IR	89	89.0%		35	83.3%		0.354
ER	2	2.0%		4	9.5%		0.063
Scap Y	92	92.0%		38	90.5%		0.749
Neer classification							
1	51	51.0%		21	50.0%		0.283
2	27	27.0%		16	38.1%		
3	17	17.0%		5	11.9%		
4	5	5.0%		0	0.0%		
AO classification							
A1	27	27.0%		17	31.0%		0.446
A2	42	42.0%		16	40.8%		
A3	7	7.0%		4	7.7%		
B1	13	13.0%		2	10.6%		
B2	3	3.0%		0	2.1%		
C1	1	1.0%		1	1.4%		
C2	6	6.0%		1	4.9%		
C3	1	1.0%		1	1.4%		
Ipsilateral UE fx	5	5.0%		1	2.4%		0.670
Dislocation	3	3.0%		7	16.7%		0.008

SD standard deviation, *N* number, *AP* anteroposterior, *IR* internal rotation, *ER* external rotation, *Scap Y* scapular Y, *UE* upper extremity

shoulder (which include an axillary view), no explicit verbal communication was provided to the emergency room physician or technologist in every case to ensure that an axillary view was obtained or at least attempted. Thus, the true rate of a successful axillary view acquisition may be underestimated. This method of surveying surgeons for treatment recommendations of proximal humerus fractures based on these radiographic views has not been previously validated and should be recognized as a further study limitation. Also, the comparison of treatment recommendations when considering imaging with and without the axillary view was limited to each individual reviewer. That is to say that a true inter-rater reliability was not calculated. We believe that an inter-rater comparison would provide an inappropriate means of assessing whether the axillary view influenced decision making as each reviewing surgeon has their own personal bias towards what the appropriate treatment should be. To limit this bias, we therefore limited the treatment comparison to each individual reviewer. The reader should also understand that a formal cost analysis was not performed for this study. Dollar value figures were queried in order to understand, on a basic level, the associated costs of re-ordering and sending a patient back to radiology in order to get an additional axillary view. No formal economic evaluation was done; thus, any discussion of costs should consider this as a limitation. Lastly, an a priori power analysis was not conducted for this investigation. Thus, it is not truly known if analysis showing no difference is truly attributable to equivalence or rather due to a lack of power to detect a difference.

It is well-known to orthopedic surgeons taking care of patients in the emergency room setting that obtaining a quality axillary radiograph is a challenge. By definition, these patients with proximal humerus fractures or shoulder

Table 3 Intraobserver reliability of treatment recommendations for all three reviewers based upon radiographic review without an axillary view

No axillary view				
Rater	Kappa	95% CI (L)	95% CI (U)	*p* value
1	0.790	0.649	0.880	0.000
2	0.816	0.693	0.895	0.000
3	0.876	0.793	0.929	0.000

CI (L) confidence interval lower limit, *CI (U)* confidence interval upper limit

Table 4 Intraobserver reliability of treatment recommendations for all three reviewers based upon radiographic review with an axillary view

Axillary view				
Rater	Kappa	95% CI (L)	95% CI (U)	*p* value
1	0.847	0.744	0.912	0.000
2	0.784	0.639	0.876	0.000
3	0.801	0.668	0.886	0.000

CI (L) confidence interval lower limit, *CI (U)* confidence interval upper limit

Table 5 Agreement between treatment recommendations with and without an axillary view for each reviewer

Comparison of no axillary view vs. axillary view				
Rater	Kappa	95% CI (L)	95% CI (U)	*p* value
1	0.759	0.660	0.858	<0.0001
2	0.808	0.719	0.896	<0.0001
3	0.804	0.710	0.897	<0.0001

CI (L) confidence interval lower limit, *CI (U)* confidence interval upper limit

trauma at large have significant pain and the positioning necessary for the axillary view can greatly exacerbate their symptoms. Data supports the fact that this is an uncomfortable process for patients, and the vast majority would prefer an alternative method of radiographic evaluation [5, 12]. Primarily because of this reason, the axillary view is commonly omitted by radiology technologists; in this specific study population, despite being explicitly ordered, 64% of patients did not receive the axillary view. In fact, of the 51 patients that did actually receive an axillary view, over 40% of these were done only because the on-call orthopedic resident insisted the patient return to the X-ray suite for an axillary view because it was omitted on the initial imaging series.

Clearly, the axillary view can be an uncomfortable study that is poorly tolerated by patients. This begs the question: Is the pain, time, and effort necessary to obtain an axillary view of high enough yield to justify its routine use? Dogma has dictated that this is a mandatory view when evaluating patients with shoulder trauma, but the existing data on this very subject is surprisingly unsupportive. De Smet et al. found that the axillary view was able to detect pathology not seen on other radiographic projections in only 15 of 239 shoulders [4]. It should be noted that these were patients with atraumatic shoulder pain, and the findings were primarily rotator cuff calcification and glenohumeral osteoarthritis. Prato et al. examined 126 traumatized shoulders and found that the axillary view was accurate for detecting pathologic conditions in only 60% of cases, compared to 88% with the AP view [10]. The axillary view has been shown to be less than ideal for detecting tuberosity displacement. A cadaver study by Parsons et al. simulated greater tuberosity fractures, and a variety of views were taken in order to determine which were best suited to detect displacement [7]. The AP view with the arm in external rotation was the ideal view for detecting small amounts of greater tuberosity displacement, and the axillary view was not any more useful than other views for this purpose. Surprisingly, Levy et al. found that the axillary view is not the best view for detecting displacement of isolated lesser tuberosity lesions [6]. They reported on four cases of post shoulder arthroplasty patients in which there was a displacement of the lesser tuberosity osteotomy; the displacement of the lesser tuberosity osteotomy was observed only on the true AP radiograph and was not detectable with an axillary view. The axillary view has also shown to be highly inaccurate for assessing the true amount of angulation of simulated surgical neck fractures in cadavers [13]. Even when considering only glenohumeral dislocation, a condition in which it is a widely held belief that an axillary view is absolutely mandatory, the axillary view does not seem to add any diagnostic value. Pavlov et al. reported that in a population of unstable shoulders that the Hill-Sachs lesion was best observed with the internal rotation and the Stryker notch views and bony Bankart lesions were best visualized with either the Didiee or West Point view, the axillary view did not add any additional preoperative diagnostic information in these instability cases [8]. Silfverskiold et al. concluded from their study of 75 dislocations that the scapular Y was superior to the axillary view when evaluating dislocated shoulders [12]. The scapular Y view confirmed dislocation in 100% of cases, compared to only 92% of cases with the axillary view. Additionally, the scapular Y could be performed more easily by the technologists and generated less discomfort for patients. Eighty-one percent of patients from this series preferred the scapular Y because they reported it was less painful.

In this study, we sought to better quantify the utility of the axillary view in terms of whether this additional view would influence clinical decision making regarding treatment of proximal humerus fractures. Each of the three reviewers each demonstrated excellent agreement between treatment recommendations for fractures evaluated with and without the axillary view. This confirmed our hypothesis that the axillary view adds no real diagnostic value that sufficiently influences management of proximal humerus fractures. This conclusion is supported by the previously cited literature. Based on all of this data, it seems that the axillary view may be more of a luxury than a necessity when evaluating patients with shoulder trauma. Obtaining this view is not trivial, as it is potentially very painful for the patient and time-consuming for the radiology technologist. Furthermore, if the patient does not receive an axillary view and is sent back explicitly for this view, this poses serious costs. At our institution, each time this occurs, it increases the billed charges by over $250, not including the hidden costs of time necessary to perform the repeat axillary view which could be dedicated to other patients and the time cost to the technologist and the orthopedic surgeon who frequently must be present in the radiology suite to position and hold the arm. Finally, many of these patients with proximal humerus fractures or other forms of shoulder girdle trauma will ultimately go on to receive advanced imaging, such as a CT scan, which provides a superior level of diagnostic information, thus further rendering the axillary view of little utility. When considering all of these factors, it may be reasonable, if not prudent, to forgo the use of the axillary view in the assessment of proximal humerus fractures and perhaps shoulder trauma in general.

In this study, we found that an axillary view and complete trauma series of the shoulder were obtained in the minority of patients at our institution. No specific fracture pattern or patient characteristic correlated with the ability to image the shoulder. The axillary view did not provide any information sufficient to influence clinical decision making with regard to proximal humerus fractures. Considering that the axillary view is painful, labor-intensive, generates additional costs to the patient and health care system at

large, and does not appear to provide any additional diagnostic value, orthopedic surgeons can consider foregoing the use of the axillary view when evaluating and treating proximal humerus fractures.

Disclosures

Conflict of Interest: Marschall B. Berkes, MD, Jacqueline F. Birnbaum, BA, Lionel E. Lazaro, MD, Tristan C. Lorich, Milton T.M. Little, MD, Joseph T. Nguyen, MPH and Dean G. Lorich, MD have declared that they have no conflict of interest. Joshua S. Dines, MD is a consultant for Conmed Linvatec, Tornier Sports Medicine, and Biomimetics and reports grants from the Institute of Sports Medicine Research, outside the work.

Human/Animal Rights: All procedures followed were in accordance with the ethical standards of the responsible committee on human experimentation (institutional and national) and with the Helsinki Declaration of 1975, as revised in 2008 (5).

Informed Consent: Informed consent was waived from all patients for being included in the study.

Required Author Forms Disclosure forms provided by the authors are available with the online version of this article.

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