

Reverse Total Shoulder Arthroplasty for Geriatric Proximal Humerus Fracture Dislocation With Concomitant Nerve Injury

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Abstract

Introduction: Preoperative axillary nerve palsy is a contraindication to reverse total shoulder arthroplasty (rTSA) due to the theoretical risk of higher dislocation rates and poor functional outcomes. Treatment of fracture-dislocations of the proximal humerus with rTSA is particularly challenging, as these injuries commonly present with concomitant neurologic and soft tissue injury. The aim of the current study was to determine the efficacy of rTSA for this fracture pattern in geriatric patients presenting with occult or profound neurologic injury. **Methods:** A retrospective case series of all shoulder arthroplasty procedures for proximal humerus fractures from February 2006 to February 2018 was performed. Inclusion criteria were patients aged greater than 65 years at the time of surgery, fracture-dislocations of the proximal humerus, and treatment with rTSA. Patients with preoperative nerve injuries were compared to patients without overt neurologic dysfunction. Forward elevation, Quick Disabilities of the Arm, Shoulder, and Hand (QuickDASH), Visual Analog Scale (VAS), and Subjective Shoulder Value (SSV) were obtained at final follow-up. **Results:** Forty-six rTSA for acute fracture were performed during the study period, 16 patients met the inclusion criteria and 5 (31%) presented with overt preoperative nerve injuries. At mean 3.1 years follow up, there were no postoperative complications including dislocations and final forward elevation was similar between study groups. Patients with overt nerve palsy had higher QuickDASH and VAS scores with lower SSV and self-rated satisfaction. **Discussion:** In the majority of patients with or without overt nerve injury, rTSA reliably restored overhead function and led to good or excellent patient-rated treatment outcomes. Overt nerve palsy did not lead to higher complication rates, including dislocation. Despite greater disability and less satisfaction, complete or partial nerve recovery can be expected in the majority of patients. **Conclusion:** Nerve injury following proximal humeral fracture dislocation may not be an absolute contraindication to rTSA.

Keywords

nerve injury, axillary nerve, proximal humerus, fracture-dislocations, reverse total shoulder arthroplasty, brachial plexus, deltoid palsy

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Introduction

Reverse total shoulder arthroplasty (rTSA) has excellent mid- and long-term outcomes but initial stability of the implant depends on its semiconstrained design and surrounding muscle forces, namely the deltoid muscle.¹⁻¹¹ Numerous studies state that preoperative brachial plexus nerve injury is a contraindication to rTSA citing the theoretical risk of higher dislocation rates and poor functional outcomes.^{4-8,10-13} Treatment of fracture-dislocations of the proximal humerus with rTSA is particularly challenging, as these injuries commonly present with concomitant neurologic and soft tissue injury, particularly in the elderly population. The aim of the current study was to

determine the efficacy of rTSA in geriatric patients presenting with proximal humerus fracture-dislocation and occult or profound muscular and/or neurologic dysfunction.

Concomitant neurologic injury in the setting of proximal humerus fracture dislocations has been reported in multiple

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series ranging from 6.2% to 67%.¹⁴⁻¹⁷ These injuries commonly involve the axillary nerve and are difficult to diagnose as lateral sensation can be unreliable and motor examination is often unachievable.¹⁶ These devastating injuries have questionable and variable recovery and must be taken into consideration while formulating an appropriate surgical plan.^{14,17} Though some patients may have overt neurologic injuries demonstrable at the time of presentation, most fracture-dislocation patients do have some component of neurologic insult, even if this is not readily apparent on their initial trauma evaluation. Outcomes in those patients with readily apparent concomitant nerve injuries will be evaluated and compared to patients without gross nerve dysfunction on initial evaluation. We hypothesize that an overt preoperative brachial plexus injury will lead to a higher complication rate and lower outcome scores in geriatric patients undergoing a rTSA for a fracture-dislocation of the proximal humerus.

Methods

The study was a retrospective case series review of a single surgeon's patients who underwent shoulder arthroplasty procedures performed for proximal humerus fractures from February 2006 to February 2018 at a single institution. The study was performed after approval by the institutional review board at the authors' institution (IRB# PRO13090583). Inclusion criteria were patients aged greater than 65 years at the time of surgery, fracture-dislocations of the proximal humerus, and treatment with rTSA. Exclusion criteria included arthroplasty for 3-part, 4-part, and head-splitting fractures of the proximal humerus without humeral head dislocation, fractures treated with open reduction internal fixation or shoulder hemiarthroplasty, arthroplasty procedures performed for proximal humeral nonunions, and conversion arthroplasty procedures.

Demographic data was obtained by chart review. All patients by protocol underwent preoperative computed tomography scan for surgical planning and these studies were used to differentiate true fracture-dislocations from complex, comminuted fracture patterns. Preoperative overt brachial plexus palsy was defined by a constellation of examination findings including the inability to fire deltoid (axillary nerve), biceps (musculocutaneous nerve), triceps or wrist extension (radial nerve), hand grip (median nerve), or finger abduction (ulnar nerve). Posterior deltoid strength examination was understandably difficult to reliably quantify in the traumatic setting. Final forward elevation was defined as the ability or inability to raise the operative arm to a level parallel to floor or above. Validated functional outcome measures including the Quick Disabilities of the Arm, Shoulder, and Hand (QuickDASH), Visual Analog Scale (VAS), and Subjective Shoulder Value (SSV) were obtained at final follow-up.^{18,19} The QuickDASH is an 11-item questionnaire scored from 0 (no disability) through 100 (most severe disability) that gauges the physical function and symptoms in patients with upper extremity injuries. The VAS is a widely used pain scale questionnaire that is scored from 0 to 100, with higher scores indicating greater pain. The

Table 1. Postoperative Forward Elevation Parallel to Floor.

Forward Elevation Parallel to Floor		
No Overt Palsy (n = 11) 9 of 11	Palsy (n = 4) 2 of 4	Difference (P Value) .5165

SSV is a patient's subject assessment of their shoulder expressed as a percentage of a normal shoulder, with 100% being the highest score indicating normal function.

All statistical analysis was performed with GraphPad Prism 7.0 (La Jolla, California), and $P < .05$ was considered statistically significant. Univariate analysis of continuous variables was conducted with a Student t test, and a Fisher exact test was used for categorical variables.

Results

There was a total of 131 shoulder arthroplasties for fracture during the time period studied. All surgeries were performed by a single surgeon, who is fellowship-trained in traumatology (I.S.T.). No rTSA was performed from 2006 to 2011 and 51 rTSA were performed from 2012 to 2018, including 46 for acute fracture. Sixteen patients met the inclusion criteria and 5 (31%) of these patients presented with gross preoperative brachial plexus palsy. Mean age was 73.4 years (range 66-84 years) and mean follow-up was 3.1 years (range 1-5 years) with 1 patient deceased (from the brachial plexus palsy group). There were no postoperative complications, dislocations, or additional surgery after the index procedure.

Among all patients studied, there was no significant difference in final forward elevation ($P = .52$, Table 1). Mean QuickDASH scores were significantly higher in the brachial plexus palsy group (63.05) compared to those without overt brachial plexus palsy (30.98; $P = .0178$). Those with brachial plexus palsy reported more pain according to VAS scores at final follow-up, but this difference did not reach statistical significance ($P = .23$). Subjective Shoulder Value was lower in the brachial plexus palsy group (48.75% vs 73.64%), but this difference also failed to meet statistical significance ($P = .15$). Fifty percent of patients in the brachial plexus palsy group rated the treatment outcome as good or excellent compared to 82% of patients without overt nerve injury (Table 2; Figures 1-3).

Discussion

In the majority of patients with or without overt nerve injury, rTSA reliably restored overhead function and led to good or excellent patient-rated treatment outcomes at a mean 3.1 years after surgery. At final follow-up, patients with an overt preoperative brachial plexus palsy did report more disability and were slightly less satisfied with their outcome. This finding was expected; however, an overt preoperative brachial plexus palsy did lead to more significantly more pain, and did not

Table 2. Patient-Reported Functional Outcomes.

	No Overt Palsy		Palsy		Difference (P Value)
	(n = 11)		(n = 4)		
	Mean	SD	Mean	SD	
QuickDASH	30.98	6.41	63.05	8.26	.02
VAS	2.55	2.38	4.75	4.43	.23
SSV	73.64%	24.91%	48.75%	36.14%	.15

Abbreviations: QuickDASH, Quick Disabilities of the Arm, Shoulder, and Hand; SD, standard deviation; SSV, Subjective Shoulder Value; VAS, Visual Analog Scale.

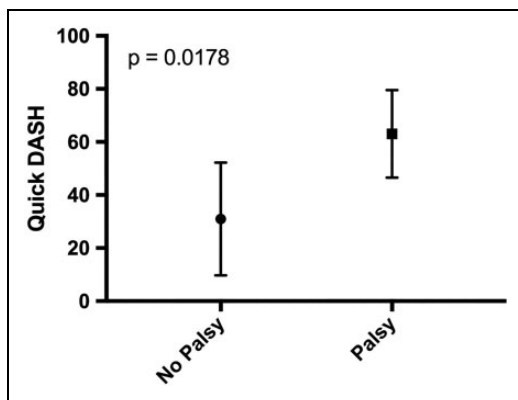


Figure 1. QuickDASH outcome: No Palsy versus Palsy. QuickDASH indicates Quick Disabilities of the Arm, Shoulder, and Hand.

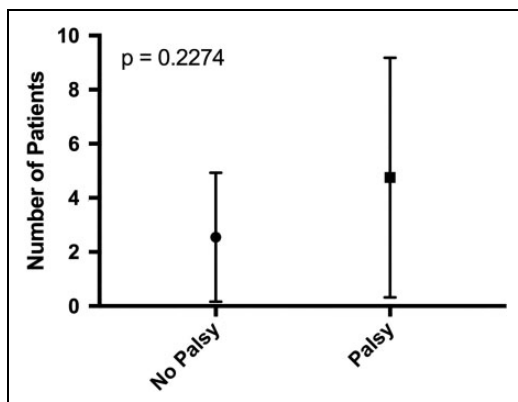


Figure 2. Visual analog scale outcome: No Palsy versus Palsy.

significantly limit final forward elevation or lead to higher complication rates, including dislocation.

Proximal humerus fracture-dislocations in the geriatric population have traditionally presented a technical challenge to the orthopedic surgeon.^{1,4,5,7,13,20,21} Since its introduction to the United States in 2004, rTSA has become a popular and reliable alternative form of treatment these patients.^{20,22} Advantages of rTSA include immediate stability and utilization of the shoulder following surgery which may not be possible after open reduction internal fixation due to poor bone quality and/or fracture comminution. Whereas hemiarthroplasty reliably

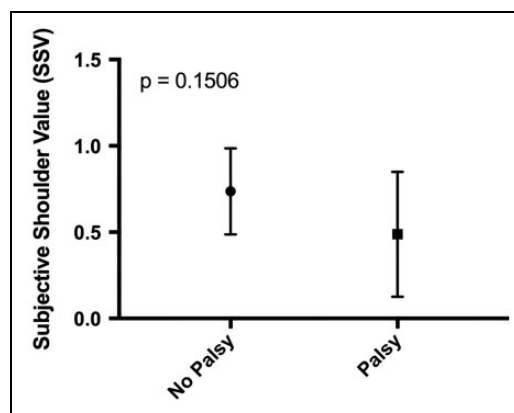


Figure 3. Subjective Shoulder Value outcome: No Palsy versus Palsy.

relieves pain, trends toward increased utilization of rTSA for complex fractures in elderly patients have been based on reports of superior functional outcomes.^{12,20,23} This trend was exemplified in our study, as no rTSA for proximal humeral fracture was performed from 2006 to 2011, followed by a period of increased utilization (n = 46) in the subsequent 6 years studied. Furthermore, mean functional outcomes in our study as measured by the QuickDASH are comparable with previous reports in regard to disability after surgery.^{2,7,24-28}

The reported incidence of concomitant neurologic injury after proximal humerus fractures ranges from 6.2% to 67%.¹⁴⁻¹⁷ Thirty-one percent of patients in our series presented with an overt brachial plexus injury, but the true incidence of neurologic insult in those difficult to examine preoperatively, is unknown and difficult to elicit on an initial trauma evaluation. Postoperatively, electromyography can be useful in the investigation of nerve injury as clinical examination continues to be unreliable due to pain, poor patient cooperation, and associated soft tissue injury and healing.^{14,16,17} Electromyography-confirmed nerve lesions after proximal humeral fractures have been studied.^{14,16,17} Displaced fractures, fracture-dislocations, associated fracture hematoma, and age >65 years at presentation have all been shown to be risk factors for concomitant neurologic injury, most commonly involving the axillary nerve.^{4,6,7} Complete or partial neurologic recovery in this setting has been reported.^{7,22} Four months after surgery, one study of 101 patients showed only 8% with persistent motor loss.⁷ All patients with preoperative palsy in our study exhibited neurologic recovery within 3 years of surgery without any reported or treated dislocations. An important concept is stopping the cycle of injury to the brachial plexus. In patients with overt brachial plexus palsies, we suspect that shaft medialization from the fracture-dislocation causes continued and repetitive insult to the brachial plexus. Performing rTSA allows for cessation of this vicious cycle, and allows the healing process to begin. In essence, the semiconstrained rTSA provides splintage of the injury to allow for neurologic recovery.

Conventional teaching precludes the use of rTSA in the context of axillary nerve palsy or deltoid dysfunction given its critical role to function and stability. Dislocation following

treatment of proximal humerus fractures with rTSA is a commonly reported complication. This was highlighted in a recent systematic review citing dislocation (16.7%) to be more common than infection (6.8%), perioperative fracture (3.0%), or intraoperative nerve injury (2.6%).²⁷ Proximal humeral fracture dislocations are also a risk factor for postoperative instability given the associated soft tissue injury to the capsuloligamentous and muscular envelope of the shoulder. Two other studies specifically evaluating rTSA outcomes following proximal humeral fractures in the elderly reported dislocation rates from 6% to 11%, with a propensity for dislocation in those presenting with fracture-dislocations.^{12,20} However, a recent study evaluating rTSA outcomes in 49 patients with preoperative deltoid dysfunction reported dislocations in only 2 patients (4.1%) at a mean follow-up of 38 months.⁹ This study included 13 patients treated for “sequelae of trauma” but did not specify how many of these patients were surgically indicated for acute fracture.⁹ The authors conclude that, in certain circumstances, preoperative deltoid impairment is not an absolute contraindication to rTSA.⁹ Consistent with this finding, there were no cases of reoperation or dislocation in our study group including those with overt nerve injury. Prior to neurologic recovery, semiconstrained rTSA implant design in these patients appears to provide sufficient splintage without failure, despite the functional absence of the overlying muscular envelope.

There are several limitations to this study including a sample size too small to appropriately power the statistical analysis and retrospective design which is subject to selection and observation bias and fails to determine absolute risk or incidence. With regard to patient evaluation, an independent observer did not measure final forward elevation, and preoperative nerve palsy were not objectively measured. Likewise, the incidence of a brachial plexus injury is unknown in those presenting without overt signs of neurologic dysfunction.

Conclusion

This study demonstrates favorable patient-reported outcomes, function, pain, and pain control after rTSA for treatment of proximal humeral fracture-dislocations in geriatric patients presenting with occult or profound muscular and/or neurologic dysfunction. Patients with overt preoperative palsies did exhibit disability at final follow-up. However, these injuries are difficult to treat, and creating a stable shoulder without significantly more pain than a neurologically-intact counterpart is favorable. The semiconstrained rTSA provides splintage of this unstable injury to allow for pain control, and more importantly stops the cycle of ongoing injury otherwise imparted to the brachial plexus. None of the patients with overt brachial plexus palsy sustained a postoperative dislocation and, as a majority, were still able to achieve final forward elevation above the level of the chin. As such, preoperative brachial plexus palsies may not be an absolute contraindication to rTSA as complete or partial recovery in most patients can be expected. Appropriate preoperative counseling to establish expectations is critical in

this setting. Future studies in this area are necessary to further our understanding and validate this treatment paradigm.


Declaration of Conflicting Interests

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