Journal of Shoulder and Elbow Arthroplasty
Volume 3: 1–6

DOI: 10.1177/2471549219840441
journals.sagepub.com/home/sea
SAGE

Risk Factors for Mortality and Readmission After Shoulder Hemiarthroplasty for Fracture

Anshuman Singh, MD[1], Mark Schultzel, MD[1], Guy Cafri, PhD[2], Edward H Yian, MD[3], Mark T Dillon, MD[4], and Ronald A Navarro, MD[5]

Abstract

Background: Limited information exists regarding mortality and readmission following proximal humerus fracture. This study examines risk factors following hemiarthroplasty for these fractures.

Methods: A retrospective analysis of prospectively collected data on 788 patients treated with hemiarthroplasty for acute proximal humerus fracture from January 2005 to December 2011 was conducted. One-year mortality and 30- and 90-day hospital readmission were evaluated. Patient risk factors included age, race, gender, diabetes, American Society of Anesthesiologists (ASA) score, and body mass index.

Results: One-year mortality rate was 5.2%. Patients with ASA $\geq$3 had 2.37 times (95% confidence interval [CI]: 1.05–5.32) greater mortality risk versus patients with ASA1/2. The 30-day readmission rate was 8.4% and at 90 days was 12.6%. Females had 0.53 risk of readmission versus males (95% CI: 0.29–0.96). Patients with ASA $\geq$3 had 1.79 (95% CI: 1.04–3.09) risk of 90-day readmission versus patients with ASA1/2; females had 0.52 (95% CI: 0.31–0.85) risk of readmission versus males. Increased age increased all odds ratios.

Conclusions: Readmission rate after hemiarthroplasty for proximal humerus fracture is significant both at 30 and 90 days and is higher in males. Age and ASA $\geq$3 correlate with this. Diabetes and obesity were not significant risk factors for readmission or mortality.

Keywords

Mortality, readmission, shoulder hemiarthroplasty, humerus fracture

Date received: 27 August 2018; revised: received 18 February 2019; accepted: 6 March 2019

Introduction

Approximately 1 in 3 women and 1 in 5 men will sustain an osteoporotic fracture in their lifetime.[1,2] By 2025, there will be over 3 million such fractures in the United States.[1] Proximal humerus fractures are the third most common osteoporotic fracture, accounting for 10% of fractures in the Medicare population.[3,4] These fractures are most commonly associated with low energy falls, and the incidence is increasing.[3,5–8]

Management of minimally displaced proximal humerus fractures is often nonoperative. As the severity of fractures increases, so does the likelihood of operative treatment.[9] There are several options for treating severe 3 and 4 part proximal humerus fractures.[8–10] One of the

[1]Southern California Permanente Medical Group, Department of Orthopaedics, San Diego, California
[2]Surgical Outcomes and Analysis, Kaiser Permanente, San Diego, California
[3]Southern California Permanente Medical Group, Department of Orthopaedics, Anaheim, California
[4]The Permanente Medical Group, Department of Orthopaedics, Sacramento, California
[5]Southern California Permanente Medical Group, Department of Orthopaedics, Torrance, California

Corresponding Author:
Mark Schultzel, Southern California Permanente Medical Group, Department of Orthopaedic Surgery, 400 Craven Road, San Marcos, CA 92078, USA.
Email: mschultzel@gmail.com

most commonly employed procedures is hemiarthroplasty.[4,9–11] The results of hemiarthroplasty have been reported in regard to shoulder function, pain relief, and complications, but in an era of increasing scrutiny of quality measures, there is little information that addresses risk factors for readmission or mortality after hemiarthroplasty for proximal humerus fracture.[12–20]

The aim of this study was to determine patient risk factors for 30-day and 90-day readmission as well as 1-year mortality following hemiarthroplasty for the treatment of proximal humerus fractures.

Materials and Methods

Study Design, Data Collection, and Inclusion Criteria

A retrospective cohort study was conducted. Patients were identified using a large nationally integrated health-care system Shoulder Arthroplasty Registry (SAR). Details on the data collection mechanisms, outcomes, and participation of the SAR have been previously published.[19,20] Forty-seven hospitals participated in the SAR. As of December 2011, the SAR contained over 6200 procedures including total shoulder arthroplasty, hemiarthroplasty, humeral head resurfacing, and reverse total shoulder arthroplasty performed for both elective and traumatic indications. A trained clinical content expert, with extensive knowledge of the clinical definitions relevant to this study, reviewed the patients' electronic medical records after initial identification of the procedures. Characteristics of the patients and procedures were extracted from the operative reports that had been reviewed by the clinical content expert.

Patients registered from January 2005 (the start of the registry) to December 2011 were included in the study, allowing for 6 years and over 780 procedures to be evaluated. These end points were selected, as they had the highest rate of participation in the registry and most accurately captured the representative patient population in this system. Only primary unilateral procedures were included; in 5 individuals who had 2 primaries performed only the first primary procedure was included. Pathologic fractures were excluded.

Outcome of Interest

There were 3 end points for this study: 1-year mortality, and all-cause 30-day and 90-day readmission. Readmissions were defined as any inpatient readmission within 30 and 90 days of the discharge date of the original procedure.

Covariates

Patient risk factors evaluated included race (White, Black, Hispanic, Asian, Other), gender, diabetes diagnosis, American Society of Anesthesiologists (ASA) score (<3 vs ≥ 3), body mass index (BMI) (continuous). Age (categorical) was evaluated as a risk factor for readmission but was regarded strictly as a confounder when mortality was the outcome.

Statistical Analyses

Frequencies, proportions, mean, and standard deviations (SDs) were used to describe the study sample. P values are based on a χ^2 test or Student's t test with pooled variance. If patients left the integrated health-care system before a 30- or 90-day readmission occurred, they were treated as lost to follow-up (1 left within 30 days and 5 left within 90 days). A similar approach was not taken for 1-year mortality because mortality information was available after membership termination. Generalized Estimating Equations were used to model the relationship between the covariates and each of the outcomes (1-year mortality, 30-day readmission, 90-day readmission) in multivariable models that accounted for the clustering of surgical cases within surgeon. Instead of imposing a linear constraint on the relationship between age and the logit, we allowed for a possible nonlinear relationship by dividing age into 10 groups using deciles. Missing data were handled using multiple imputations with 100 imputed data sets and the imputation model consisting of all exposure variables in the analysis models, the 3 response variables, BMI (log transformed), and race variables. Rubin's rules for calculating parameter estimates and standard errors across imputed data sets were used. For some imputed data sets involving mortality as the response, the intraclass correlation was negative when the working correlation structure was compound symmetric. Therefore, we chose to use an independence working correlation structure while still using the robust standard error approach.[21] For the readmission models, a compound symmetric working correlation structure was used. Odds ratios (ORs), 95% confidence intervals (CIs), and P values are reported. Data were analyzed using SAS (Version 9.2, SAS Institute, Cary, NC), and $\alpha = .05$ was used as the statistical significance threshold.

Results

A total of 788 acute primary hemiarthroplasty fracture patients were identified. See Table 1 for sample description. Patients were predominantly female (76.3%), White (79.7%), and not obese (55.5% had BMI $< 30\,kg/m^2$). The prevalence of diabetes was 35.8%, and 53.1% had

Table 1. Patient Characteristics, Overall and by 1-Year Death, 30-Day Readmission, and 90-Day Readmission Status.

	Total Sample	No Death	Death Within 1 Year		No 30-Day Readmit	30-Day Readmit		No 90-Day Readmit	90-Day Readmit	
	Mean (SD)	Mean (SD)	Mean (SD)	*P*	Mean (SD)	Mean (SD)	*P*	Mean (SD)	Mean (SD)	*P*
Age	70.8 (11.6)	70.38 (11.5)	78.99 (11.5)	<.001	70.41 (11.7)	75.4 (9.3)	<.001	70.3 (11.6)	74.8 (10.7)	<.001
	N (%)	N (%)	N (%)		N (%)	N (%)		N (%)	N (%)	
Race										
Asian	27 (3.4)	26 (96.3)	1 (3.7)	.611	25 (92.6)	2 (7.4)	.436	24 (88.9)	3 (11.1)	.314
Black	22 (2.8)	22 (100)	0 (0.0)		21 (95.5)	1 (4.5)		21 (95.5)	1 (4.5)	
Other	18 (2.3)	18 (100)	0 (0.0)		18 (100)	0 (0.0)		18 (100.0)	0 (0.0)	
White	625 (79.7)	590 (94.4)	35 (5.6)		567 (90.7)	58 (9.3)		540 (86.4)	85 (13.6)	
Hispanic	92 (11.7)	88 (95.7)	4 (4.3)		87 (94.6)	5 (5.4)		82 (89.1)	10 (10.9)	
Unknown	4	3 (75.0)	1 (25.0)		4 (100.0)	0 (0.0)		4 (100.0)	0 (0.0)	
Gender										
Male	187 (23.7)	176 (94.1)	11 (5.9)	.632	167 (89.3)	20 (10.7)	.190	157 (84)	30 (16)	.100
Female	601 (76.3)	571 (95)	30 (5.0)		555 (92.3)	46 (7.7)		532 (88.5)	69 (11.5)	
Diabetes										
No	506 (64.2)	480 (94.9)	26 (5.1)	.913	465 (91.9)	41 (8.1)	.711	441 (87.2)	65 (12.8)	.749
Yes	282 (35.8)	267 (94.7)	15 (5.3)		257 (91.1)	25 (8.9)		248 (87.9)	34 (12.1)	
ASA										
<3	335 (46.9)	326 (97.3)	9 (2.7)	.005	313 (93.4)	22 (6.6)	.047	306 (91.3)	29 (8.7)	.002
>3	380 (53.1)	352 (92.6)	28 (7.4)		339 (89.2)	41 (10.8)		317 (83.4)	63 (16.6)	
Unknown	73	69 (94.5)	4 (5.5)		70 (95.9)	3 (4.1)		66 (90.4)	7 (9.6)	
BMI, kg/m^2										
<30	429 (55.5)	403 (93.9)	26 (6.1)	.037	390 (90.9)	39 (9.1)	.813	370 (86.2)	59 (13.8)	.502
[30–35)	172 (22.3)	169 (98.3)	3 (1.7)		158 (91.9)	14 (8.1)		152 (88.4)	20 (11.6)	
>35	172 (22.3)	167 (97.1)	5 (2.9)		159 (92.4)	13 (7.6)		154 (89.5)	18 (10.5)	
Unknown	15	8 (53.3)	7 (46.7)		15 (100.0)	0 (0.0)		13 (86.7)	2 (13.3)	

Abbreviations: ASA, American Society of Anesthesiologists; BMI, body mass index; SD, standard deviation.
Square bracket "[" indicates value inclusive and parentheses "(" indicates value exclusive.

an ASA score of ≥3 at the time of surgery. The mean age at the time of surgery was 70.8 years old (SD = 11.6).

Readmission

Of the 788 individuals in the cohort, there were 66 (8.4%) all-cause readmissions within 30 days and 99 (12.6%) all-cause readmissions within 90 days. With respect to 30-day readmissions, gender was the only significant risk factor after multivariable adjustment, with females having a lower risk than males (OR = 0.53, 95% CI: 0.29–0.96). With 90-day readmissions, both ASA score and gender were significantly associated with the end point. Those with an ASA score ≥3 had increased the odds of 90-day readmission by a factor of 1.79 (95% CI: 1.04–3.09) and being female decreased the odds of 90-day readmission by a factor of 0.52 (95% CI: 0.31–0.85). Advanced age significantly increased the OR for readmission versus the reference cohort.

Mortality

There were 41 (5.2%) deaths in the cohort 1 year after proximal humerus fracture. The only significant risk factor associated with death within 1 year, after adjusting for the covariates, was intraoperative ASA score (Table 2). An ASA score of ≥3 was associated with higher odds of death by a factor of 2.37 (95% CI: 1.05–5.32). Age significantly increased the OR for mortality versus the reference cohort.

Discussion

This study analyzed a cohort of 788 patients and identified patient risk factors for 30- and 90-day readmission as well as 1-year mortality.

Readmission

Our overall readmission rate was 8.4% at 30 days and 12.6% at 90 days. This rate is lower than all-cause readmission after hip fracture, which is reported to be 11.8% at 28 days to 19.0% at 90 days.[22,23] The disparity in readmission may be attributable to hip fracture patients on average being more elderly, more medically complicated, and with a resultant loss of ambulatory capacity.

Table 2. Risk Factors of 1-Year Mortality, 30-day Readmission, and 90-day Readmission in Patients With Primary Acute Fracture Hemiarthroplasty (Generalized Estimating Equation Multivariable Models).

	Death Within 1 Year				30-Day Readmit				90-Day Readmit			
	Odds Ratio	95% LB	95% UB	*P*	Odds Ratio	95% LB	95% UB	*P*	Odds Ratio	95% LB	95% UB	*P*
Gender Reference group: Males	0.63	0.29	1.38	.250	0.53	0.29	0.96	.036	0.52	0.31	0.85	.010
ASA score Reference group <3	2.37	1.05	5.32	.037	1.39	0.78	2.46	.261	1.79	1.04	3.09	.035
DiabetesReference group: No	0.98	0.51	1.87	.954	0.99	0.60	1.64	.965	0.82	0.51	1.31	.407
Age categories Reference group: [27.9, 55.9)[a]												
[55.9, 61.2)	4.67	0.47	46.37	.189	–[b]	–	–	–	2.18	0.58	8.14	.245
[61.2, 64.1)	0.98	0.06	17.48	.992	3.27	0.80	13.36	.100	1.99	0.50	7.89	.330
[64.1, 68.3)	1.02	0.06	17.85	.988	4.2	1.13	15.68	.033	2.46	0.71	8.53	.157
[68.3, 71.7)	1.88	0.15	23.64	.626	3.97	1.06	14.96	.041	2.28	0.68	7.66	.181
[71.7, 75.1)	4.95	0.51	48.05	.168	4.77	1.19	19.02	.027	3.37	0.92	12.28	.066
[75.1, 77.9)	1.8	0.16	20.67	.638	3.33	0.83	13.30	.089	3.52	0.93	13.32	.064
[77.9, 81.0)	7.43	0.73	75.45	.090	4.88	1.29	18.41	.019	3.83	1.17	12.55	.027
[81.0, 85.3)	5.02	0.54	46.4	.155	4.86	1.31	18.02	.018	3.00	0.87	10.33	.081
[85.3, 101.2]	12.91	1.44	115.93	.022	7.04	2.00	24.74	.002	5.81	1.59	21.20	.008

Abbreviations: ASA, American Society of Anesthesiologists; BMI, body mass index; LB, lower bound; UP, upper bound.
Square bracket "[" indicates value inclusive and parentheses ")" indicates value exclusive.
[a]The reference group for the 30-day readmit models is [27.9, 61.2), because the original reference group had 0 events.
[b]No estimates because there are no events in this group.

We found patients with an ASA score ≥3 had nearly 80% higher risk of readmission versus individuals with ASA 2 or lower at 90 days after shoulder hemiarthroplasty. These data have not been reported for this population and should help providers inform patients and their families regarding surgical risk preoperatively. Females had roughly half the risk of readmission at both 30 and 90 days relative to males. It is unclear why females were less likely to be readmitted. In a similarly powered study, Khan et al. evaluated 28-day readmission patients with hip fracture but did not find a difference between males and females.[23]

Mortality

Mortality data are limited for proximal humerus fractures treated with hemiarthroplasty. In a study of deep vein thrombosis (DVT) rates and mortality, Navarro et al. reported a 0.5% 90-day mortality rate in 2574 elective shoulder arthroplasty cases.[24] Farng et al. noted a 90-day mortality of 2.9% in fracture patients treated with arthroplasty.[13] In our study, the 1-year mortality rate for all patients was 5.2% and increased to 6.3% for patients aged 64 years and older.

There are robust data on the 1-year mortality following hemiarthroplasty for femoral neck fractures. In these studies, the 1-year mortality was found to be between 11% and 34%.[18,25–32] Risk factors for increased mortality after hip fracture include time to surgery, ASA score, and age.[28]

Our findings support relative risk of mortality at 1 year after shoulder fractures treated with hemiarthroplasty to be nearly 25%; this finding is similar to that of hip fractures treated with hemiarthroplasty. The difference in mortality between hip and shoulder fractures is possibly related to the retained ambulatory capacity in shoulder fractures as well as other factors such as patient comorbidities, blood loss, age, and postoperative incidence of DVT. In addition, the majority of hip fractures are treated operatively regardless of comorbidities, whereas surgeons may recommend nonoperative management of proximal humerus fracture in a medically compromised individual.[7,8,11,18,28]

In terms of risk factors for mortality, patients with an ASA score of 3 or more had 2.4 times the 1-year mortality risk compared to patients with an ASA score of 1 or 2. To our knowledge, there are no comparable studies for shoulder hemiarthroplasty in the current literature. However, Singh et al. have evaluated the effect of ASA score on 90-day mortality after elective total shoulder arthroplasty,[33] finding patients who were ASA class 3 or 4 had a 3.6 and 13.4 times greater risk of mortality after surgery, respectively. Farng et al.[13] did not evaluate ASA score, although they did examine other risk factors for 90-day mortality and found fracture patients with high Charleston comorbidity indexes and vascular disease had a higher 90-day complication rate.

There are several strengths to this study. First, our study findings can be generalized to most practice settings, as the health plan captures a large representative

cross-section of the U.S. population. The cohort evaluated consists of cases from many surgeons and hospitals.[34] The relatively large study cohort allowed for a more in-depth statistical analysis of risk factors than previously reported in the literature. A final strength of the study is the high internal validity of the information presented, as all cases included had been validated through chart review and actively monitored by graduate-level staff.

Our limitations include only examining patients with proximal humerus fractures treated with hemiarthroplasty. These findings do not apply to patients treated with reverse total shoulder arthroplasty, internal fixation, or nonoperative treatment. We also could not determine the impact that implant and procedure characteristics had on the outcomes examined or the impact of time from injury to surgery due to the still small sample size of our study to conduct more complex analysis. Furthermore, we did not distinguish between fracture subtypes. Intraoperative factors such as operative time, blood loss, and surgeon experience were not analyzed. Potential confounders such as smoking, workers compensation, income level, and medication history were not analyzed. Another limitation is that we did not study the reasons for readmission to the hospital in this study. This is a preliminary study of mortality and readmission after shoulder fractures, examining the impact of other risk factors (eg, surgical, implant, and hospital factors), and reasons for readmission may serve as the basis for future studies.

Conclusions

In conclusion, hemiarthroplasty for proximal humerus fracture carries a substantial 30-day (8.4%) and 90-day (12.6%) readmission rate as well as 1-year mortality rate (5.2%). ASA score of 3 and over, male gender, and advanced age were independent risk factors for readmission. ASA and advanced age were risk factors for mortality. Diabetes and obesity had no effect on mortality or readmission risk. Surgeons, patients, and families may use these results to better understand the risk factors for readmission and death following shoulder hemiarthroplasty for proximal humerus fracture.

Declaration of Conflicting Interests

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article

Funding

The author(s) received no financial support for the research, authorship, and/or publication of this article.

ORCID iD

Mark Schultzel http://orcid.org/0000-0001-5994-2869

References

1. Burge R, Dawson-Hughes B, Solomon DH, Wong JB, King A, Tosteson A. Incidence and economic burden of osteoporosis-related fractures in the United States, 2005-2025. *J Bone Miner Res*. 2007;22:465–475.
2. Center JR, Nguyen TV, Schneider D, Sambrook PN, Eisman JA. Mortality after all major types of osteoporotic fracture in men and women: an observational study. *Lancet*. 1999;353:878–882.
3. Baron JA, Karagas M, Barrett J, et al. Basic epidemiology of fractures of the upper and lower limb among Americans over 65 years of age. *Epidemiology*. 1996;7:612–618.
4. Kontakis G, Koutras C, Tosounidis T, Giannoudis P. Early management of proximal humeral fractures with hemiarthroplasty: a systematic review. *J Bone Joint Surg Br*. 2008;90:1407–1413.
5. Kannus P, Palvanen M, Niemi S, Sievänen H, Parkkari J. Rate of proximal humeral fractures in older Finnish women between 1970 and 2007. *Bone*. 2009;44:656–659.
6. Kannus P, Parkkari J, Koskinen S, et al. Fall-induced injuries and deaths among older adults. *JAMA*. 1999;281:1895–1899.
7. Lauritzen JB, Schwarz P, Lund B, McNair P, Transbøl I. Changing incidence and residual lifetime risk of common osteoporosis-related fractures. *Osteoporos Int*. 1993;3:127–132.
8. Rothberg D, Higgins T. Fractures of the proximal humerus. *Orthop Clin North Am*. 2013;44:9–19.
9. Min W, Davidovitch RI, Tejwani NC. Three-and four-part proximal humerus fractures: evolution to operative care. *Bull NYU Hosp Jt Dis*. 2012;70:25–34.
10. Vallier HA. Treatment of proximal humerus fractures. *J Orthop Trauma*. 2007;21:469–476.
11. Naranja RJ Jr, Iannotti JP. Displaced three- and four-part proximal humerus fractures: evaluation and management. *J Am Acad Orthop Surg*. 2000;8:373–382.
12. Boons HW, Goosen JH, van Grinsven S, van Susante JL, van Loon CJ. Hemiarthroplasty for humeral four-part fractures for patients 65 years and older: a randomized controlled trial. *Clin Orthop Relat Res*. 2012;470:3483–3491.
13. Farng E, Zingmond D, Krenek L, Soohoo NF. Factors predicting complication rates after primary shoulder arthroplasty. *J Shoulder Elbow Surg*. 2011;20:557–563.
14. Lanting B, MacDermid J, Drosdowech D, Faber KJ. Proximal humeral fractures: a systematic review of treatment modalities. *J Shoulder Elbow Surg*. 2008;17:42–54.
15. Prakash U, McGurty DW, Dent JA. Hemiarthroplasty for severe fractures of the proximal humerus. *J Shoulder Elbow Surg*. 2002;11:428–430.
16. Robinson CM, Page RS, Hill RM, Sanders DL, Court-Brown CM, Wakefield AE. Primary hemiarthroplasty for treatment of proximal humeral fractures. *J Bone Joint Surg Am*. 2003;85-A:1215–1223.

17. Spross C, Platz A, Erschbamer M, Lattmann T, Dietrich M. Surgical treatment of Neer Group VI proximal humeral fractures: retrospective comparison of PHILOS(R) and hemiarthroplasty. *Clin Orthop Relat Res*. 2012;470:2035–2042.
18. Martinez-Huedo MA, Jiménez-García R, Mora-Zamorano E, Hernández-Barrera V, Villanueva-Martinez M, Lopez-de-Andres A. Trends in incidence of proximal humerus fractures, surgical procedures and outcomes among elderly hospitalized patients with and without type 2 diabetes in Spain (2001–2013). *BMC Musculoskelet Disord*. 2017;18:522.
19. Paxton EW, Inacio MC, Kiley M-L. The Kaiser Permanente implant registries: effect on patient safety, quality improvement, cost effectiveness, and research opportunities. *Perm J*. 2012;16:36–44.
20. Paxton EW, Kiley M-L, Love R, Barber TC, Funahashi TT, Inacio MC. Kaiser Permanente implant registries benefit patient safety, quality improvement, cost-effectiveness. *Jt Comm J Qual Patient Saf*. 2013;39:246–252.
21. Hanley JA, Negassa A, Edwardes MD. GEE analysis of negatively correlated binary responses: a caution. *Stat Med*. 2000;19:715–722.
22. Hahnel J, Burdekin H, Anand S. Re-admissions following hip fracture surgery. *Ann R Coll Surg Engl*. 2009;91:591–595.
23. Khan MA, Hossain FS, Dashti Z, Muthukumar N. Causes and predictors of early re-admission after surgery for a fracture of the hip. *J Bone Joint Surg Br*. 2012;94:690–697.
24. Navarro RA, Incacio M, Burke M, Costouros J, Yian E. Effect of traumatic indication and implant type on symptomatic VTE rates in shoulder arthroplasty. *Clin Orthop Relat Res*. 2013;417:1576–1581.
25. Baudoin C, Fardellone P, Bean K, et al. Clinical outcomes and mortality after hip fracture: a 2-year follow-up study. *Bone*. 1996;18:149S–157S.
26. Haidukewych GJ, Israel TA, Berry DJ. Long-term survivorship of cemented bipolar hemiarthroplasty for fracture of the femoral neck. *Clin Orthop Relat Res*. 2002;(403):118–126.
27. Keene GS, Parker MJ, Pryor GA. Mortality and morbidity after hip fractures. *BMJ*. 1993;307:1248–1250.
28. Lim YW, Kwon SY, Han SK, Sun DH, Choi SP, Kim YS. Postoperative mortality and factors related to mortality after bipolar hemiarthroplasty in patients with femoral neck fractures. *J Arthroplasty*. 2009;24:1277–1280.
29. Parker M, Johansen A. Hip fracture. *BMJ*. 2006;333:27–30.
30. Taylor F, Wright M, Zhu M. Hemiarthroplasty of the hip with and without cement: a randomized clinical trial. *J Bone Joint Surg Am*. 2012;94:577–583.
31. Wilson LA, Gooding BW, Manning PA, Wallace WA, Geoghegan JM. Risk factors and predictors of mortality for proximal humeral fractures. *Shoulder Elbow*. 2014;6:95–99.
32. Park C, Jang S, Lee A, et al. Incidence and mortality after proximal humerus fractures over 50 years of age in South Korea: national claim data from 2008 to 2012. *J Bone Metab*. 2015;22:17–21.
33. Singh JA, Sperling JW, Cofield RH. Ninety day mortality and its predictors after primary shoulder arthroplasty: an analysis of 4,019 patients from 1976–2008. *BMC Musculoskelet Disord*. 2011;12:231.
34. Paxton EW, Namba RS, Maletis GB, et al. A prospective study of 80,000 total joint and 5000 anterior cruciate ligament reconstruction procedures in a community-based registry in the United States. *J Bone Joint Surg Am*. 2010;92 Suppl 2:117–132.