Hip Fractures Are Risky Business: An Analysis of the NSQIP Data

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Purpose: The recent expansion of the American College of Surgeons National Surgical Quality Improvement Program (ACS-NSQIP) database provides an unparalleled opportunity to analyze the highest-risk orthopaedic surgeries. In this study, we begin by utilizing ACS-NSQIP data to compare the rate of 13 adverse events among the 30 most common orthopaedic procedures. We then use our findings to investigate risk factors and complication rates among the top five surgeries found to have the greatest rate of adverse events in orthopaedic surgery.

Methods: Using the ACS-NSQIP database, a prospective cohort of 101,862 orthopaedic patients from 2005-2011 were categorized by CPT codes. Demographics including age, sex, race, and comorbidities were recorded. The incidence of 13 adverse events was calculated. For the 5 procedures with the greatest rate of adverse events, the most common postoperative complications and risk factors for adverse events were identified. Statistical significant was set at $P < 0.05$.

Results: The top 5 orthopaedic procedures with the highest rate of adverse events were all hip fracture surgeries (n = 9460). Adverse events occurred in 15.9% to 27.4% of cases among these 5 procedures (Figure 1). These surgeries also accounted for 25.2% (2433/9640) of all adverse events in orthopaedics. Among the top 5 procedures, the most common adverse events were death (6.90%), urinary tract infection (UTI) (5.92%), and pneumonia (3.45%) (Table 1). Five significant risk factors were identified for adverse events following hip fracture repair, including age, history of CHF (congestive heart failure), esophageal varices, ASA (American Society of Anesthesiologists) class, and functional status (Table 2).

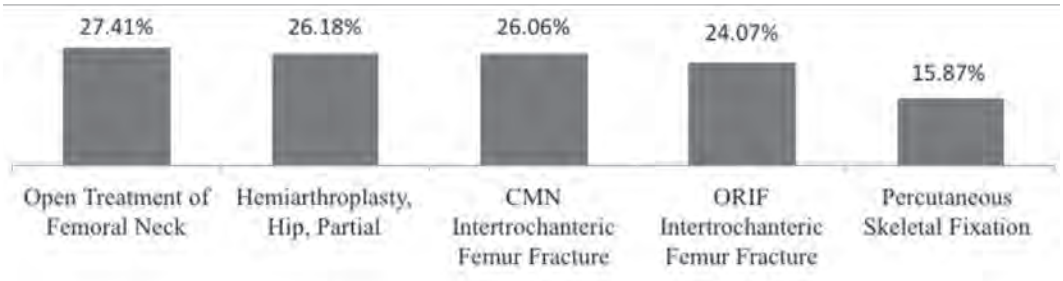

Figure 1. Orthopaedic procedures with the greatest rate of adverse events. CMN = cephalomedullary nailing, ORIF = open reduction and internal fixation.

Conclusion: This study, which is the first to use the expanded orthopaedic ACS-NSQIP database, demonstrates that over one-third of all adverse events in orthopaedics are due to hip fractures. Quality improvement programs targeted towards hip fracture patients, especially those with the risk factors identified above, can dramatically reduce adverse events in orthopaedic trauma.

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Table 1. Top Five Complications Following Hip Fracture Repair	
Death	6.90% (n = 665)
Myocardial infarction	1.69% (n = 163)
Sepsis	2.02% (n = 195)
UTI	5.92% (n = 571)
Pneumonia	3.45% (n = 333)

Table 2. Risk Factors for Adverse Events Following Hip Fracture		
Risk Factors	Odds Ratio (95% Confidence Interval)	*P*
Age >65 years	1.37 (1.07-1.75)	0.013
History of CHF	1.85 (1.31-2.62)	0.0001
Esophageal varices	3.73 (1.20-11.6)	0.022
ASA class	1.26 (1.72-2.78)	0.0001
Functional status	2.33 (2.12-2.56)	0.0001

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Trauma Triage Scores Inadequately Assess Geriatric Patients

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Purpose: The objective of this study was to identify variables that predict mortality in geriatric trauma patients. We hypothesized that current trauma triage scores that were designed from younger, high-energy patient cohorts would not accurately predict the mortality risk for geriatric patients. Additionally we hypothesized traditional triage factors (age, vital signs, anatomic injuries) may require different weighting in the geriatric trauma population to account for differences in injury characteristics and physiology that occur with increasing age.

Methods: After obtaining IRB approval, we utilized the Trauma Registry to identify all geriatric trauma patients (age ≥55 years) who presented to our Level I trauma center from 2008-2011. Patients with a predicted probability of survival of 10%-75% based on the Trauma Score-Injury Severity Score (TRISS) were identified. This cohort with predicted intermediate mortality risk was selected because triage decision-making is less clear than with patients in the lower or upper bounds and, therefore, the sensitivity and specificity of the triage tool is more critical. A total of 247 patients met our inclusion criteria and had complete data. Ten patients were excluded for death in the emergency room. The remaining cohort of 237 patients was divided into survivors and nonsurvivors for analysis. The following triage variables that have been reported to have a role in predicting survival were analyzed: age, mechanism of injury, laboratory values, and vital signs upon arrival at the trauma center. The ISS and TRISS were calculated for both survivor and nonsurvivors.

Results: Of the 237 patients analyzed, 109 (46%) died during the index hospitalization (nonsurvivors) and 128 (54%) survived (survivors). There was no difference between survivors and nonsurvivors for gender (61% vs. 58% male; $P = 0.594$). The mean age for nonsurvivors was significantly higher than for survivors (74 years vs. 67 years; $P < 0.001$). 68% of nonsurvivors versus 43% of survivors ($P < 0.001$) suffered injuries as a result of a low energy mechanism (fall from standing height). GCS (Glasgow Coma Scale) was significantly lower for nonsurvivors compared to survivors (5.1 vs. 7.9; $P < 0.001$). The following parameters were significantly lower for nonsurvivors compared to survivors: temperature (96 vs. 97; $P < 0.01$), respiratory rate (10.7 vs. 13.8; $P < 0.05$), and HCT (hematocrit) (34.4 vs. 36.5; $P < 0.05$). Pulse rate, blood pressure, shock index (heart rate divided by systolic blood pressure), and base deficit on arrival were not significantly different. The TRISS was predictive of survival (TRISS 0.35 vs. 0.46; $P < 0.001$) while the ISS (a measure of injury severity) was significantly lower for nonsurvivors than survivors (ISS 23 vs. 26; P <0 .001).

Conclusion: In spite of its widespread adoption and use, the ISS is a poor predictor of mortality in an intermediate-risk geriatric trauma population as evidenced by lower triage scores for nonsurvivors when compared with survivors. Those patients in our cohort who survived had a higher probability of survival based on the TRISS, but the difference between groups was quite small, suggesting that the TRISS lacks the requisite specificity

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to be used as an accurate prediction model in the geriatric patient. Older age, lower GCS, and a low-energy mechanism of injury are associated with a higher mortality rate in this geriatric population seen at an urban Level I trauma center. Given the inability of existing measures to adequately predict mortality in older adults, existing measures may be missing key variables that impact survival of traumatic injuries. This information sets the stage for the development of a triage tool specific to the geriatric trauma population with appropriately weighted risk factors.

Development and Validation of a Geriatric Trauma Triage Score

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Purpose: Current injury severity indices (ISIs) (eg, Injury Severity Score [ISS], Trauma Score-Injury Severity Score [TRISS]) were developed in a high-energy, young adult population that translates poorly to the geriatric population. We sought to develop a novel, easy-to-use triage tool to identify inpatient mortality risk in geriatric trauma patients upon arrival in the emergency department.

Methods: The patient population consisted 2940 and 1605 low-energy and high-energy geriatric (≥55 years old) trauma patients (LE-GTPs and HE-GTPs, respectively) treated at a single Level I trauma center from 2008-2011 that were identified from Trauma Registry. Low-energy was defined as a ground-level fall and high-energy was defined as trauma resulting from a fall from height, motor vehicle or motorcycle accident, or pedestrian struck. In phase 1, we evaluated the ability of current ISIs to predict mortality for LE- and HE-GTPs using area under the receiver operating characteristic curve (AUROC). In phase 2, a backwards stepwise regression analysis (using <0.05 as the significance threshold) was used to create a novel low-energy and high-energy geriatric trauma triage score (LE-GTTS and HE-GTTS, respectively) using 4 core-host variables (age, preexisting conditions via the Charlson Co-morbidity Index (CCI), anatomic injuries via the Abbreviated Injury Scale (AIS), and physiologic status via vital signs). We compared the ability of the new scores versus current ISIs to detect inpatient mortality. In phase 3 we validated these scores using AUROC analysis with 37,474 LE-GTPs and 97,034 HE-GTPs from the National Trauma Databank (NTDB).

Results: LE-GTPs were 9.1 years older than HE-GTPs (75.8 ± 11.0 vs. 66.7 ± 9.2, $P < 0.01$). The overall mortality rate for LE-GTPs vs. HE-GTPs was 7.9% vs. 7.0% ($P < 0.01$) Phase 1: TRISS was found to be the most predictive existing ISI for both cohorts and was deemed to have moderate predictive capacity in the low-energy cohort and excellent predictive capacity in the high-energy cohort (LE-GTP AUROC: 0.82 vs. HE-GTP AUROC: 0.91; $P < 0.01$). Phase 2: The LE-GTTS was found to have the following variables included in the final model (data type, odds ratio): age (continuous, odds ratio [OR]: 1.05), CCI (ordinal, OR: 1.28), Glasgow Coma Scale (GCS) (ordinal, OR: 0.72), AIS-Head & Neck (ordinal, OR: 1.67), and AIS-Chest (ordinal, OR: 1.52). The predictive capacity of the LE-GTTS was significantly better than TRISS (AUROC 0.89 vs. 0.82, $P < 0.01$). The HE-GTTS was found to have the following variables included in the final model: age (continuous, OR: 1.12), GCS (ordinal, OR: 0.69), AIS-Head & Neck (ordinal, OR: 1.77), AIS-Chest (ordinal, OR: 1.51), and AIS-Extremity (ordinal, OR: 1.59). The predictive capacity of the HE-GTTS was significantly better than TRISS (AUROC 0.96 vs. 0.91, $P < 0.01$). Phase 3: In the NTDB, the LE-GTTS and HE-GTTS were both found to be significantly more predictive of mortality than TRISS (LE-GTTS AUROC: 0.82 vs. 0.79, $P <0.01$; HE-GTTS AUROC: 0.86 vs. 0.85, $P <0.01$).

Conclusion: The LE-GTTS and HE-GTTS are novel triage scores developed specifically for geriatric trauma patients. They are intended to triage patients to lower or higher levels of

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care / monitoring from the emergency department setting. These scores have been validated in the NTDB and should therefore be valid to use prospectively in the clinical setting. Future work will focus on the development of clinical guidelines to improve triage decision-making.

Does Anesthesia Type Influence Risk of Perioperative Complications in Hip Fracture Surgery?

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Purpose: Several recent studies have advocated the use of regional anesthesia (spinal and regional nerve blocks) over general anesthesia as a means of reducing the risk of perioperative complications associated with geriatric hip fracture surgery. However, conclusive evidence demonstrating clinically significant differences in complication rates between regional and general anesthesia in this patient population does not exist. We sought to explore further the impact of anesthesia type on perioperative complications in hip fracture surgery using the recently expanded American College of Surgeons National Surgical Quality Improvement Program (ACS-NSQIP) database—a large, multicenter, prospective cohort of hip fracture patients.

Methods: Four CPT codes (27235, 27236, 27244, and 27245) representing the spectrum of hip fracture surgery were used to identify a prospective cohort of 7808 hip fracture patients from 2005-2011 in the ACS-NSQIP database. Only patients who were administered general anesthesia or regional anesthesia (spinal or nerve blocks) were included in the analysis (n = 7764). Perioperative complications were recorded and categorized as minor (wound dehiscence, superficial surgical site infection, pneumonia, and urinary tract infection) or major (death, deep wound infection, myocardial infarction, deep venous thrombosis, pulmonary embolism, peripheral nerve injury, sepsis and septic shock). Using a multivariate logistic regression analysis controlling for age, medical comorbidities, American Society of Anesthesiologists (ASA) status, operative time, and baseline functional status, perioperative complications were compared between patients receiving general anesthesia and patients receiving regional anesthesia. A χ^2 analysis was then used to compare complication rates between the two groups.

Results: 7764 patients with hip fractures were included in the final analysis**.** Rates of minor, major, and total complications by anesthesia type are displayed in Table 1. Patients undergoing surgical treatment for hip fractures who received regional anesthesia had a significantly higher risk of total complications (odds ratio [OR]: 1.05, $P = 0.025$) and minor complications (OR: 1.09, $P = 0.001$) compared with patients who were administered general anesthesia. There was no significant difference in risk of major complications between the two groups (OR: 0.99, $P = 0.720$) (Table).

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Anesthesia Type	Minor Complication Rate	Major Complication Rate	Overall Complication Rate
General	9.0% (527/5840)	12.2% (714/5840)	17.9% (1,044/5840)
Regional nerve blocks	7.2% (8/111)	8.1% (9/111)	12.6% (14/111)
Spinal	11.6% (211/1813)	11.6% (211/1813)	19.6% (356/1813)
Total	9.6% (746/7764)	12.0% (934/7764)	18.2% (1414/7764)
OR, confidence interval (CI), *P* value	OR: 1.09, 95% CI: 1.035-1.150, ***P* = 0.001**	OR: 0.99, 95% CI: 0.940-1.043, *P* = 0.72	OR: 1.05, 95% CI: 1.006-1.094, ***P* = 0.025**

Conclusion: In this large prospective cohort of patients with hip fractures, regional anesthesia was associated with a small (OR = 1.05) but statistically significant increase in the risk of perioperative complications compared with general anesthesia. This increased risk is driven by a higher risk of minor complications in the regional anesthesia group (OR = 1.09). Considering the small odds ratios, the clinical significance of these findings remains unclear. Nonetheless, our results do not support the conclusions of several recent studies, which suggest decreased rates of perioperative complications with regional as compared to general anesthesia.

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Efficacy of Scheduled Intravenous Acetaminophen Pain Management Protocol in Hip Fractures

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Purpose: Hip fractures are a common problem in the geriatric population, having wide-reaching effects including functional decline and economic impact on the health-care system. Prior studies have demonstrated both the safety of intravenous (IV) acetaminophen and its efficacy in decreasing perioperative narcotic consumption. The purpose of this study was to determine whether the implementation of a scheduled IV acetaminophen perioperative pain protocol during geriatric hip fracture treatment influenced length of hospital stay (LOS), pain level, narcotic use, physical therapy (PT) participation, and discharge disposition.

Methods: After IRB approval was obtained, a retrospective CPT code (27235, 27236, 27244, 27245) search was performed and the charts were reviewed of all patients 65 years or older admitted to the orthopaedic service at a Level I trauma center who underwent operative treatment for a hip fracture from June 1, 2011 through May 31, 2013. The patients were divided into two cohorts; the first (Group 1) consisted of patients treated before the initiation of a standardized IV acetaminophen pain control protocol, and the second (Group 2) consisted of those treated after the protocol was initiated. 365 consecutive fractures in 360 patients were identified. Pathologic fractures (8), periprosthetic fractures (8), concomitant injuries requiring operative intervention (8 fractures in 7 patients), and perioperative deaths (5) were excluded. This resulted in 332 patients with 336 intertrochanteric or femoral neck fractures (169 fractures in Group 1, 167 fractures in Group 2) with a mean age of 83 years (range, 65-101).

Results: There was no statistically significant difference in demographic data (age, gender, fracture classification, body mass index) or time from admission to the operating room between the two cohorts. Group 2 had a shorter mean LOS (4.4 vs. 3.8 days), lower mean visual analog scale (VAS) pain score (4.2 vs. 3.8), lower mean narcotic usage (41.3 vs. 28.3 mg "morphine equivalent"), lower rate of PT sessions missed (21.8% vs. 10.4%), and higher likelihood of discharge home instead of to a secondary care facility (7.1% vs. 19.2%) ($P \leq 0.001$, respectively). Separate multivariate regression analyses also demonstrated statistical significance for the utilization of IV acetaminophen as an independent predictor of decreased LOS, decreased VAS pain scores, lower narcotic usage, fewer missed PT sessions ($P < 0.001$, respectively), and increased rate of home discharge ($P = 0.008$).

Conclusion: The utilization of scheduled perioperative IV acetaminophen as part of a standardized pain management protocol for operative geriatric hip fractures is efficacious for shortening hospital length of stay, improving subjective and objective pain measures, missing fewer physical therapy sessions, and increasing home discharge rate.

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The Effect of Preoperative Transthoracic Echocardiogram on Mortality and Surgical Timing in Elderly Hip Fracture Patients

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Purpose: Heart disease is the most common cause of postoperative mortality in elderly hip fracture patients, and transthoracic echocardiogram (TTE) is often used to assess cardiac function prior to surgery. The purpose of our study was to evaluate the effect of preoperative TTE on mortality, postoperative complications, surgical timing, and length of stay in surgically treated hip fracture patients.

Methods: A retrospective chart review was performed on 694 consecutive hip fracture patients >60 years of age treated surgically at two local hospitals. Patients were identified by billing codes over a 30-month time period from July 1, 2009 to December 31, 2011. Hospital records were reviewed for age, sex, timing of admission, medical clearance, operation and discharge, admitting service, fracture and treatment type, medical comorbidities, American Society of Anesthesiologists (ASA) score, preoperative testing ordered (TTE), preoperative cardiac intervention, complications, and mortality. The Social Security Death Index was used for 30-day and 1-year mortality data when not available in the hospital records. Our primary outcome measure was in-hospital, 30-day, and 1-year mortality following hip fracture surgery in patients who receive preoperative TTE. Secondary outcome measures included complications (particularly cardiovascular) and time required for medical clearance and operative treatment.

Results: Preoperative echocardiogram was performed on 131 patients (18.9%). Patients admitted by the medicine service were 1.76 times more likely to receive preoperative TTE ($P < 0.01$). Patients were 2.28 times more likely to receive TTE if they had a history of coronary artery disease ($p < .001$), and 2.12 times more likely if they had a history of arrhythmia ($P < 0.001$). Five patients in the TTE group and one patient in the control group underwent cardiac catheterization prior to surgery, but none of these patients required angioplasty or stent placement. There was no difference in mortality between the TTE group and the control group in hospital (3.8% vs. 1.8%, $P = 0.176$), at 30 days (6.9% vs. 6.6%, $P = 0.90$), or at 1 year (20.6% vs. 20.1%, $P = 0.89$), respectively. There was no significant difference in major cardiac complications between groups. Average time from admission to operative treatment was 66.5 hours in the TTE group and 34.8 hours in the control group ($P < 0.001$). Average time from admission to medical clearance was 43.2 hours in the TTE group and 12.4 hours in the control group ($P < 0.001$). There was no difference in the time between medical clearance and operative treatment between the two groups (23.3 hours versus 22.4 hours, $P = 0.639$). The TTE group also had a significantly longer length of stay at 8.68 days compared to 6.44 days in the control group ($P < 0.001$).

Conclusion: Preoperative TTE did not help reduce mortality rates in elderly hip fracture patients in either short or long-term postoperative periods. In addition TTE delayed surgical treatment, resulted in no cardiac intervention, and increased length of stay. The American

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Heart Association (AHA) and the American College of Cardiology (ACC) have developed guidelines for perioperative assessment of patients in case of noncardiac surgery. TTE should not be used as a screening tool in hip fracture patients, but instead used to further evaluate active cardiac conditions.

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Improving Care for Older Patients with Hip Fracture

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Background/Purpose: Hip fracture is a common and increasing socioeconomic problem throughout the world. These patients present a challenge to the health-care system as they are elderly with multiple comorbidities, have high rehabilitation demands, and often require enhanced social care. Single variables within the patient pathway, such as a new implant, may make a difference to outcome but most research suggests that improvements in the entire pathway from admission through to surgery and rehabilitation are required to make the biggest impact on outcome. This pathway should include measures to reduce the risk of future falls and fragility fractures. In England, a best-practice pathway together with financial incentive and audit has been introduced to cover the entire population of the country.

Methods: The National Hip Fracture Database (NHFD) prospectively collects data for hip fracture admissions at all 186 hip fracture units in England. 6000 new patients are added to the database each month. It started in 2008 and currently holds records on 309,839 patients. The median age is 80 years and 71% are female. The best-practice pathway has evolved from 7 to 10 key standards: admissions protocol, joint orthopaedic and geriatric care, surgery within 36 hours, geriatric review within 72 hours, multidisciplinary rehabilitation, falls and osteoporosis assessments; pre- and postoperative cognitive assessment, and data submission to NHFD. Mortality data are linked to the National Office of Statistics allowing 100% follow-up for mortality. To qualify for the financial incentive, a patient must receive all 10 parts of the pathway.

Results: The best-practice pathway started in 2010 and in the first year 14,615 out of 53,443 patients (27%) received the complete pathway. The number of patients receiving the entire pathway has increased quarter by quarter so that during the year April 2012-2013, 30,627 of 56,226 patients (54.5%) received all 10 standards. A further 14,506 patients (25.8%) received 9 of 10 pathway measures, indicating that the hospitals have systems in place to deliver a good care pathway. The national 30-day mortality following hip fracture has fallen 15% from 9.2% in 2008 to 8.2% in 2013.

Conclusion: We have undertaken a project to improve hip fracture care for the entire population of a country. Using a combination of well-defined, evidenced-based practice standards that address the entire patient pathway, financial incentive and good clinical audit, there has been a significant improvement in the care pathway with an additional 30,000 patients receiving the 9 or 10 parts of the pathway within 3 years of starting the project. This has been reflected in a 15% reduction in the national 30-day mortality.

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Surgery Versus Cast Immobilization for Displaced Intra-Articular Distal Radius Fractures in Elderly Patients: A Randomized Controlled Multicenter Trial

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Purpose: The best treatment strategy for displaced intra-articular distal radial fractures in elderly patients with poor bone quality is still controversial. In this randomized controlled multicenter trial we investigated whether surgical management is more effective than cast immobilization in patients over 65 years.

Methods: Of 737 eligible individuals, 185 patients with an intra-articular distal radius fracture (AO/OTA C1, C2, C3) agreed to participate. 94 participants were assigned to surgical management with volar locking plate fixation and 91 to closed reduction and cast immobilization for 6 weeks. The primary outcome was the Short Form-36 physical component summary score (SF-36 PCS) 1 year after randomization. We also assessed other SF-36 domains, the Disabilities of the Arm, Shoulder and Hand (DASH) score, the EuroQol-5D (EQ-5D) visual analog scale (VAS) and utility index, wrist range of motion (ROM), and radiographic evaluation of the wrist 3 and 12 months after randomization.

Results: Both groups showed similar baseline characteristics concerning age, gender, fracture severity and activity status. 37 (41%) patients assigned to cast immobilization subsequently underwent surgery due to significant loss of reduction. After 1 year, surgery was not superior to cast treatment (SF-36 PCS mean difference 3.3, 95% confidence interval –0.2 to 6.8) in the intent-to-treat population. Also, no statistical or clinical benefit of surgery was apparent with regard to mean differences in DASH scores (–5.0, 95% confidence interval [CI] –11.0 to 1.0) and EQ-5D VAS scores (3.0, 95% CI –1.9 to 7.9). The surgical group showed a faster improvement in ROM of the wrist after 3 months ($P < 0.05$), but after 1 year there were no significant differences of wrist ROM in all planes between both groups. Surgical management achieved a significant better anatomic restoration of the distal radius in palmar tilt, ulnar variance, and radial height (each $P < 0.05$), but this finding was not associated with superior functional results. Outcome results were similar when analyzed according to the treatment actually received.

Conclusion: In elderly patients with a displaced intra-articular distal radius fracture, surgical fixation with volar locking plates was not superior to cast immobilization in terms of health-related quality of life and wrist function 1 year after the intervention. Cast immobilization remains the primary treatment option in this patient group, and second-line surgery in case of cast treatment failure does not compromise late outcome results.

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Determinants of Functional Outcome in Distal Radius Fractures in High Functioning Elderly Patients

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Background/Purpose: Despite numerous previous studies showing no difference between operative and nonoperative treatment of distal radius fractures in the elderly, the rate of operative fixation has increased fivefold over the last decade. We aimed to determine the influence of treatment and radiographic parameters on patient-reported functional outcomes over a 1-year period.

Methods: Patients with an acute distal radius fracture over the age of 55, and with a Canadian Study of Health and Aging (CSHA) Frailty score of 1 or 2 (high functioning, medically well) were recruited for this prospective study and treated as per the surgeon's protocol. Baseline patient characteristics were collected. Standard radiographs were obtained at the time of injury, treatment, and at 12-week follow-up. Patients provided baseline, as well as 12-week and 1-year functional outcome measures including the Patient-Rated Wrist Evaluation (PRWE), Disabilities of the Arm, Shoulder and Hand (DASH), and Short Form-36 (SF-36). Univariate analyses to evaluate the relationship between operative and nonoperative treatment, as well as various radiographic parameters, on functional outcome were performed. Linear regression analysis was carried out to determine the effect of specific radiographic parameters as well as surgical treatment on functional outcome when controlling for other important predictors.

Results: 129 patients were recruited for this study, 117 women and 12 men. The mean age of the cohort was 65.96 ± 0.67 years (range, 55-90). 70 patients underwent open reduction and internal fixation, and 59 were treated with manipulation and casting. There was no statistically significant difference in DASH score, SF-36 PCS (physical component summary) or PRWE at 52 weeks follow-up ($P = 0.963$, $P = 0.184$, $P = 0.645$). The operative group had higher PRWE pain scores (7.85 ± 1.08 vs. 6.95 ± 1.34) but this did not reach statistical significance. As expected, the operative group had a significantly worse composite radiographic score at the time of injury ($P = 0.0002$), but the two groups had very similar scores at the time of treatment ($P = 0.4303$). At 3 months postsurgery, the nonoperatively treated group had significantly worse radiographic scores ($P = 0.0006$). A univariate relationship existed between ulnar positive measurement of >2 mm and poorer DASH and SF-36 scores were seen ($P = 0.0349$, $P = 0.0385$); however, no such relationship existed for the other individual or composite radiographic parameters tested. Linear regression models controlling for operative versus nonoperative treatment, gender, age, and occurrence of a complication found a significant relationship between ulnar positivity >2 mm and change in DASH between baseline and 12 months (0.0466) as well as SF-36 PCS between 0 and 12 months (0.0383).

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Conclusion: In high-functioning elderly patients, surgical treatment produced a better radiographic result than cast treatment; however, the functional outcomes at 1 year are not statistically different. Univariate and regression analysis demonstrated a relationship between ulnar positive variance and poorer functional outcomes, but no such relationship was found for other radiographic parameters or a composite radiographic score.

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A Comparison of Primary Total Elbow Arthroplasty Versus Secondary Total Elbow Arthroplasty (Following Failed Internal Fixation) for Distal Humeral Fractures of the Elderly

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Purpose: The purpose of our study was to compare the outcome of distal humeral fractures treated with acute (primary) total elbow arthroplasty (TEA) to those treated with late (secondary) arthroplasty following failure of initial fracture fixation.

Methods: This was a single-center, retrospective, longitudinal cohort study of patients undergoing primary TEA or secondary TEA for distal humerus fracture at a single university-affiliated hospital from 1994 to 2011. Patients were initially identified through a prospectively gathered clinical database. Data captured included demographics, fracture classification, type of arthroplasty (primary or secondary), presence of complications, revision surgery, and signs of radiographic loosening. Charts were reviewed and patients were asked to return to clinic for a follow-up visit in order to capture functional outcomes. The primary outcome measure was the Disabilities of the Arm, Shoulder and Hand (DASH) score. Other outcome measures included operative parameters, Mayo Elbow Performance Score (MEPS), range of motion, ulnar nerve function, and grip strength.

Results: We identified 91 eligible patients who were treated with either primary or secondary TEA for a distal humerus fracture between 1994 and 2011. Nine patients declined participation, and 31 had died. A comprehensive chart review was performed on 82 patients with a mean follow-up of 6 years (the latest available chart data were included for patients who had died). 36 patients had a primary TEA, and 46 had a secondary TEA. In the primary group there were 7 male and 29 female patients with an average age of 77 years. In the secondary group there were 11 male and 35 female patients with an average age of 68 years. The difference in age was statistically significant ($P < 0.001$). The rate of revision was 8% (3/36) in the primary group and 20% (9/46) in the secondary group ($P = 0.12$). Two patients (6%) with a primary arthroplasty had a deep infection requiring irrigation and debridement compared to four patients (9%) in the secondary group ($P = 0.34$). 25% of patients in the primary group had postoperative neurologic symptoms in the limb compared to 22% in the secondary group ($P = 0.78$). The mean operative time was 101 minutes in the primary group and 103 minutes in the secondary group ($P = 0.89$). The mean DASH score at final follow-up was 33 in the primary group and 42 in the secondary group ($P = 0.46$). The mean MEPS at final follow-up was 85 in the primary group and 80 in the secondary group ($P = 0.45$).

Conclusion: To our knowledge, this is the largest reported comparison of primary versus secondary TEA for distal humeral fracture. There was no significant difference in functional outcome between the two groups. Our study suggests a trend that secondary TEA was associated with a higher incidence of revision compared to primary TEA, but this was

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not statistically significant (possibly due to a small sample size or beta error). Our results support TEA for either primary fracture care or secondary reconstruction of distal humeral fractures in the elderly. Additionally, these data are useful in surgical decision-making regarding these difficult injuries.

See pages 99 - 147 for financial disclosure information.