

Association Between Type of Surgery and Perioperative Acute Myocardial Infarction in Elderly Hip Fracture Patients

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Background/Purpose: Recent noncardiac surgical research suggests that perioperative myocardial infarction (MI) is becoming a dominant complication after noncardiac surgery. However, the incidence of perioperative MI in surgically treated hip fracture patients is unknown. Moreover, the impact of the type of surgery on MI risk is unknown. The aims of this study were to determine the incidence of inpatient MI in surgically treated low-energy hip fracture patients, and whether the odds of MI differed by the type of surgery (internal fixation [IF], hemiarthroplasty [HA], or total hip arthroplasty [THA]) after controlling for other factors. We hypothesized that MI risk would be highest after arthroplasty.

Methods: We used a retrospective cohort of low-energy, surgically treated hip fracture patients (ICD-9 820.x, OA / OTA 31-A, 31-B) age 65 years or older from the 2000-2009 Healthcare Cost and Utilization Project (HCUP) Nationwide Inpatient Sample. Patients with cancer, revisions, infection, or high-energy trauma were excluded. The primary outcome was acute MI; the secondary outcome was mortality. Multivariate logistic regression modeled the association between the type of surgery (IF, HA, THA) and MI, controlling for age, sex, type of fracture, and modified Charlson score without acute MI. Incidence estimates (inpatient MI and MI-associated mortality) and adjusted odds ratios (OR) from SAS survey procedures are reported.

Results: 2,275,944 discharges met inclusion criteria. The mean patient age was 83 years and most patients were female (75.6%). IF was used in 63.4% of patients; 34.0% received HA and 2.6% received THA. Nearly half of the fractures were intertrochanteric or subtrochanteric (50.9% combined) and 96.5% of these were treated with IF. Femoral neck (28.9%) and unspecified femoral neck fractures (20.2%; ICD-9 820.8, 820.9) comprised the remaining hip fractures of which 66.1% received HA and 4.8% THA. Perioperative acute MI occurred in 2.2% of patients overall. MI differed by procedure and was highest after HA (2.5%) and lowest after IF (2.0%). Multivariate analysis showed a similar pattern by procedure. The odds of acute MI were higher after HA (OR 1.46; 95% confidence interval [CI] 1.38, 1.56) and THA (OR 1.27; 95% CI 1.10, 1.46) compared with IF, after controlling for other factors. Overall, inpatient mortality after acute MI was eight times that of patients without MI (17.4% vs 2.2%) and MI-associated mortality was highest after THA (18.2%).

Conclusion: Arthroplasty was associated with higher odds of MI and higher MI-associated

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mortality than internal fixation in older hip fracture patients. Acute MI is a deadly perioperative condition after hip fracture. When considering arthroplasty for treatment of a hip fracture, the surgeon must weigh the additional MI risk and associated mortality of this procedure versus internal fixation. Routine screening for MI could improve survival since early intervention after MI improves outcomes.

Effect of Vitamin K on Surgical Timing After Hip Fracture in Patients on Warfarin*Jacob Lantry, MD; John T. Gorczyca, MD;**University of Rochester Medical Center, Rochester, New York, USA*

Purpose: This study was undertaken to characterize treatment patterns for patients sustaining a proximal femur fracture while taking warfarin.

Methods: All patients undergoing treatment of a proximal femur fracture over a 3-year period were identified using CPT codes from a surgical database at a Level I trauma center. 438 patients were identified and their charts reviewed. Patients with an international normalized ratio (INR) ≥ 1.5 at admission who were taking warfarin were included in the study. Treatment of the elevated INR was classified as either vitamin K administration or expectant management. Vitamin K administration and timing were recorded. Vitamin K administration was classified as immediate if received in the emergency department within 4 hours and delayed if given later. INR values throughout hospitalization and timing of surgery were recorded. INR values at presentation were compared using an independent samples *t* test. An analysis of variance (ANOVA) test was used to compare impact of treatment on INR over the first 24 hours, as well as on timing to surgery. Tukey HSD (honestly significant difference) was used for post hoc analysis. Fisher exact test was used to compare the percentage of patients able to go to surgery by the day after admission for each group.

Results: Of 438 patients, 40 (9.1%) had an elevated INR due to treatment with warfarin. There were 15 men and 25 women with an average age of 81 years (range, 34-100). Indications for taking warfarin were: atrial fibrillation (27), history of thromboembolic disease (8), both atrial fibrillation with history of thromboembolic disease (3), and prosthetic valve replacement (2). INR on admission averaged 2.2 (range, 1.5-4.1) for those managed expectantly and 2.8 (range, 1.6-7.4) for those treated with vitamin K ($P = 0.06$). 28 patients were treated with vitamin K and 12 patients were managed expectantly. Of patients treated with vitamin K, the medication was administered an average of 6.7 hours after the return of the initial INR laboratory value (range, 1-20 hours). Those who received immediate vitamin K (within 4 hours) had an average correction of 1.3 in their INR within 24 hours while those who had delayed administration had a correction of 0.3 and those who did not receive vitamin K had an average increase of 0.2 ($P = 0.04$). Post hoc testing showed significance was due to difference between the immediate vitamin K and expectant management groups ($P < 0.01$). When vitamin K was given immediately, 75% of patients had surgery by the day after admission. When managed expectantly, 58% went to surgery by this time and when vitamin K treatment was delayed, 31% went to surgery by the day after admission ($P = 0.06$). No patient in any group had thromboembolic complication from correction of coagulopathy.

Conclusion: Treatment of the coagulopathic patient requiring urgent surgery is controversial and complicated. Patients who receive vitamin K early have quicker correction of INR. Patients who did not receive vitamin K showed no significant improvement in INR for 24 hours (average increase of 0.2) despite the fact that the INR was significantly lower. Most patient who received early vitamin K got surgery within 24 hours.

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Healing Time and Complications in Surgically Treated Atypical Femur Fractures Associated With Bisphosphonate Use: A Multicenter Series

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Background/Purpose: Atypical femur fractures associated with bisphosphonate use have been reported to have high nonunion rates and delayed healing. However, published trials have had small patient numbers limiting their conclusions. The purpose of this study is to characterize the demographics, rate of union, healing time, and complications of a large series of surgically treated atypical bisphosphonate femur fractures as well as the natural history of the contralateral femur.

Methods: All bisphosphonate-related fractures as defined by the ASBMR (American Society for Bone and Mineral Research) task force document from 15 centers were reviewed in detail. To be included, patients had to have been treated with bisphosphonates for at least 12 months. Fractures had to be operatively treated and followed for at least 6 months or to union or revision. Average follow-up was 16 months. Data collected included demographics, medication history, prodromal history, injury and surgery characteristics, complications, revision surgery, and time to union. Information about the contralateral limb, when available, was recorded including prodromal symptoms, radiographic signs of stress, and subsequent fracture.

Results: There were 196 patients, 178 women and 18 men, average age 73 years (range, 32-96) and average BMI (body mass index) 27.5; 77% had at least one additional medical risk factor including diabetes, rheumatoid arthritis, thyroid disease, or smoking. 20% of patients had a prior history of fragility fracture, 34% had prodromal pain in the extremity, and 19 of 135 that had clear documentation had pain in the contralateral extremity. 98% percent

were ambulatory, 28% with an assistive device, and 85% were living independently prior to the fracture. Patients averaged 79 (range, 12-192) months of bisphosphonate use prior to injury and 51% of patients discontinued bisphosphonates at the time of surgery. 27% had radiographic changes suggesting stress reaction prior to injury and 10% of fractures were periprosthetic. Surgical fixation was with cephalomedullary nail (50%), antegrade nail (37%), retrograde nail (5%), or plate (8%). Complications included pneumonia (4), death (4), pulmonary embolism (3), superficial or deep wound infection (7), hematoma (2), and screw removal (3). 18 patients (9%) underwent revision surgery at an average of 13 months after the initial procedure, most commonly with a cephalomedullary nail. Excluding those who required revision surgery, the average union time was 5.2 months (6.4 for plates and 5.1 for nails) for those whose time to union was clearly discernable based on visit intervals. 22% of patients took >6 months to heal. For the patients who had revision surgery, union occurred at an average of 10 months after secondary intervention, although 5 were lost to follow-up. Continuation or discontinuation of bisphosphonates did not have an effect on time to union ($P = 0.85$) or the need for revision surgery ($P = 0.51$). After fracture fixation patients achieved full ambulation at an average of 4 months, and 92% were living in their homes at the time of final follow-up (25% with help). 9% had a non-femur fragility fracture during follow-up. 20% of patients sustained a contralateral femur fracture, 23 months on average after their index procedure; 45% of these had discontinued bisphosphonate treatment at the time of their index procedure. Of those with information available, 23% had prodromal pain and 35% had a stress reaction on radiography prior to their contralateral fracture.

Conclusion: In this large, multicenter series, atypical bisphosphonate femur fractures occurred primarily in an independently living and ambulatory population. Surgery had a 9% failure rate requiring revision surgery and 22% took greater than 6 months to heal. 20% of patients developed contralateral femur fractures within 2 years, underscoring the need to evaluate the contralateral extremity for stress reactions. Most importantly, 92% were living at home and only 8% were in facilities at final follow-up. This patient population is distinctly different than osteoporotic hip fracture patients and had only a 2% mortality rate at average 16 months.

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Rehospitalization After Surgically Treated Hip Fractures: Targets for Intervention*Christopher M. McAndrew, MD; Michael J. Gardner, MD; Ellen F. Binder, MD;**William M. Ricci, MD; Eric J. Lenze, MD;**Washington University School of Medicine, St. Louis, Missouri, USA*

Background/Purpose: Unintended 30-day rehospitalization cost Medicare \$17.4 billion in 2004. The U.S. Department of Health and Human Services declared a goal of decreased rehospitalization rate by 20% in 2013. Rehospitalization rate after hip fracture is 18%, according to a Medicare claims review. This study of elderly hip fracture patients aims to identify risk factors for rehospitalization, directing future intervention and study.

Methods: Patients over 60 years of age with a femoral neck or intertrochanteric femur fracture treated surgically at 10 hospitals from May 2008 to November 2011 enrolled in a prospective cohort study. Subjects with cognitive impairment (Short Blessed Scale <14) that persisted for 1 week after surgical treatment were excluded. Scheduled periodic follow-up over 1 year was conducted by trained interviewers. At 1, 2, 4, 8, and 12-week interviews, the enrollees and their caregivers were questioned regarding new diagnoses, medications, and hospitalizations. Reasons for rehospitalization came from self or family reporting. 609 patients underwent screening for enrollment. 138 patients were excluded and 70 patients electively withdrew prior to completion of the study, leaving 471 subjects.

Results: Of 471 patients who participated in the study, 33 (7.0%) patients died during the 1-year study period. 388 subjects (82.4%) provided complete 12-week data. Of these 388 patients, 42 (10.8%) and 78 (20.1%) were rehospitalized at 30 and 90 days, respectively. Additionally, 5 patients were rehospitalized twice in the first 30 days. Categorized results show that hip-related complications (pain, dislocation, need for revision surgery) were the most common reasons for rehospitalization, making up 17% of the 30-day and 16% of the 90-day rehospitalizations. Gastrointestinal (GI) complications, including infection and bleeding, were the second most common reasons for rehospitalization at both 30 (15%) and 90 days (13%). Thromboembolism (11% and 12%) was also a common reason for return to the hospital.

Conclusion: 30-day rehospitalization (10.8%) and 1-year mortality (7.0%) rates in a cohort study of cognitively intact patients were lower than historical rates. Mechanical hip complications and hip pain were the most common reasons to be rehospitalized in the first 30 and 90 days after treatment of hip fracture. The proportion of hip complications did not change between the 30-day and 90-day time periods. Potential targets for intervention to decrease rehospitalization include orthopaedic surgical treatment, prevention of GI and pulmonary infection, and thromboembolic prevention and streamlined management.

Can an Evidence-Based Treatment Algorithm for Intertrochanteric Hip Fractures Maintain Quality at a Reduced Cost?

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Purpose: This study was undertaken to compare the treatment costs of intertrochanteric hip fractures before and after the implementation of an evidenced-based treatment algorithm using the OTA classification system.

Methods: In March 2012 a classification-based treatment algorithm for intertrochanteric hip fractures (OTA 31-A) was implemented across our academic orthopaedic surgery department that included specified implant usage for specific fracture patterns. 102 consecutive patients presenting with intertrochanteric hip fractures were followed prospectively (post-algorithm group). Another 117 consecutive patients who had been treated immediately prior to the implementation of the algorithm were identified retrospectively as a control group (pre-algorithm group). OTA classification of fracture, type of hardware implanted (sliding hip screw [SHS], short cephalomedullary nail [CMN], long cephalomedullary nail [CMNL]) and implant cost as well as treatment-related complications were recorded. Comparisons were made between the two groups. The algorithm was retrospectively applied to the pre-algorithm group to determine the potential savings that would have resulted if the protocol was followed with these cases.

Results: The demographics of the two cohorts did not differ and the percentages of fracture patterns treated were similar. Prior to implementation of the algorithm 41.9% of patients were treated with a different implant than what would have been prescribed by the algorithm. Following institution of the protocol, 89% surgeon compliance was obtained. The total implant cost prior to algorithm implementation was \$357,457 (mean: \$3,055, standard deviation [SD]: \$1311): 27% SHS, 21% CMN, and 52% CMNL; compared to \$255,120 (mean: \$2,501, SD: \$1272) post-algorithm consisting of 40% SHS, 34% CMN, and 26% CMNL. Of note patients who were treated with the algorithm had fewer complications (33% pre-algorithm vs 22.5% post-algorithm) ($P = 0.088$). The algorithm was applied retrospectively to the pre-algorithm group to determine the implants that should have been used (40% SHS, 39% CMN, 21% CMNL—similar to the distribution post-algorithm). Had the algorithm been used with the pre-algorithm cases, a total cost of \$284,500 (mean: \$2454.38, SD: \$1230.12) could have been obtained and \$70,295 potentially saved. The average cost savings per case would have been approximately \$601.

Conclusion: The implementation of an evidence-based intertrochanteric fracture classification/implant selection algorithm effectively reduced costs in our institution while maintaining quality of care with a lower rate of complications and readmissions. These cost savings are independent of any special pricing arrangements or institutional discounts that can also be arranged. This strategy has potential implications in physician gainsharing programs.

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Δ Intramedullary Versus Extramedullary Fixation of Unstable Intertrochanteric Hip Fractures: A Prospective Randomized Control Study

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Purpose: This study was designed to evaluate the clinical and radiological results of patients with unstable intertrochanteric hip fractures stabilized with an extramedullary device versus an intramedullary (IM) device. The hypothesis is that there would be no significant difference in clinical or radiological outcomes between the two groups.

Methods: 205 patients with unstable (AO-A2) intertrochanteric fractures were enrolled in the study and randomly assigned to receive a DHS or an IM device. The patients were followed for 12 months. Their function was assessed using the Lower Extremity Measure (LEM), a 2-minute walk test, the Timed Up and Go (TUG) test, the functional independent measure (FIM), and a Trendelenburg test. The radiographs were evaluated for tip-to-apex distance (TAD), femoral neck shortening, and heterotopic ossification. Patients were evaluated initially, at 6 weeks, and 3, 6, and 12 months postoperatively.

Results: 168 patients completed the 12-month follow-up visit. Two DHS implants and one TFN failed and required revision to hip arthroplasties. No significant differences were found in the primary outcome, the LEM scores, at any of the follow-up time points. Furthermore, there was no difference in any of the other clinical parameters between the two groups. Radiographically, the intramedullary devices led to less femoral neck shortening and the DHS led to less Brooker stage 1 and 2 heterotopic ossification.

Conclusion: While the use of intramedullary devices radiographically leads to less femoral neck shortening when compared to the DHS for the treatment of unstable intertrochanteric fractures, this does not translate into a better clinical outcome.

Is Immediate Weight Bearing Safe for Periprosthetic Distal Femur Fractures Treated With Locked Plating?

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Background/Purpose: Periprosthetic distal femur fractures (PPDFx) associated with total knee replacement are increasing in incidence. In a previous study we showed that these patients had higher mortality and morbidity, if they were not mobilized quickly. Similar to hip fracture patients, early mobilization, facilitated by weight bearing as tolerated on post-operative day 1, resulted in improved outcome and 1-year survivorship. We hypothesized that treating PPDFx with minimally invasive locked plating, incorporating the described principles of effective bridge plating, and permitting immediate full weight bearing as tolerated would result in few hardware failures and a low rate of complications.

Methods: This was a prospective cohort study of all PPDFx with stable prostheses treated by two fellowship trained orthopaedic traumatologists at a Level I trauma center. Patients were treated by a prospective protocol including admission and evaluation to a hospitalist service from the emergency department, surgery within 24 hours, standardized DVT (deep vein thrombosis) prophylaxis initiated prior to surgery, minimally invasive locked plating, postoperative weight bearing as tolerated, and standardized follow-up for 1 year. Pertinent data collection included demographics, time to surgery, blood loss, length of surgery, perioperative complications, length of stay, disposition status, time to full weight bearing, time to healing, and delayed complications including, nonunion, hardware failure, infection, and symptomatic malunion.

Results: 44 fractures were treated in 42 patients. 72% were female. Mean age was 74. 41 fractures (93%) healed within 20 weeks (mean 16 weeks). There were 2 hardware failures, 1 deep infection, 1 nonunion, and 2 patients with symptomatic malunion. There were 8 symptomatic DVTs (19%) and 1 pulmonary embolism, despite consistent anticoagulation. One patient died within 12 months of injury (2.3%). 31 patients (74%) by one year had returned to their preinjury ambulation status. The hardware failure patients had identifiable technical errors, notably short plates compared to the fracture length.

Conclusion: Locked plating for PPDFx as part of a standardized approach to geriatric fracture management, which includes early surgery and immediate weight bearing, is safe and effective. We found a low morbidity and mortality rate with this approach. Hardware failure can likely be avoided by ensuring appropriate plate length and adequate screw fixation to comply with fixation principles in osteopenic bone. We found no complications related to preoperative DVT prophylaxis. Despite following national guidelines, the most common complication was symptomatic DVT. These results represent a significant overall improvement compared to historical treatments and are likely due to overall better care due to standardized geriatric fracture management as well as technical advances in fracture fixation. We recommend fixating periprosthetic distal femur fractures with locked plates and encouraging immediate weight bearing.

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