Perioperative Considerations in Geriatric Patients With Hip Fracture: What Is the Evidence?

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Summary: Geriatric hip fracture management requires a specialized treatment algorithm secondary to the complex medical and social needs of this patient demographic. The overall goal of the treatment is early mobilization, in an effort to prevent the complications associated with prolonged recumbency and to return the patient to functional activity. There is near-universal agreement among orthopedic surgeons that fractures about the hip require operative fixation, but surgical management in this patient population brings with it a set of issues that require important consideration. The current article reviews the perioperative considerations associated with geriatric hip fractures and takes an evidence-based look at the complex issues involved in managing these patients.

Key Words: evidence based medicine, geriatric, hip fracture, Trauma

(*J Orthop Trauma* 2009;23:386–394)

INTRODUCTION

Hip fracture in the elderly patients with osteoporosis is a frequent injury constituting a major source of morbidity and mortality.[1–3] The majority of hip fractures result from relatively low energy trauma due to a combination of weaker reflexes to cushion the impact of a fall and bones weakened by osteoporosis.[4,5] With the aging of the American population, the incidence of hip fractures is projected to double from 250,000 in 1990 to 650,000 by 2040.[6,7] This constitutes a major public health problem, which is anticipated to consume a large proportion of available healthcare resources.[3,7–9]

Geriatric fracture management requires a specialized treatment algorithm secondary to the complex medical and social needs of this patient demographic. The overall goal of treatment is early mobilization, in an effort to prevent the complications associated with prolonged recumbency and to return the patient to functional activity. There is near-universal agreement among orthopedic surgeons that fractures about the hip require operative fixation, but surgical management in this patient population brings with it a set of issues that require important consideration. The current article reviews the perioperative considerations associated with geriatric hip fractures and takes an evidence-based look at the complex issues involved in managing these patients.

INDICATIONS FOR SURGERY

Operative fixation of the fractured hip continues to be the standard of care, even in the geriatric patient population. Surgical repair allows for the institution of early mobilization, limiting the period of recumbency, and allows patients to return more rapidly to functional activity. Nonoperative management of the geriatric hip fracture has been associated with excessive rates of medical morbidity and mortality. Mobilizing this patient population through fracture fixation helps in the prevention of decubiti, urinary tract infections, atelectasis and respiratory infections, thrombophlebitis, deep venous thrombosis (DVT), and pulmonary embolus (PE). However, the orthopedic surgeon must weigh operative indications against issues unique to the elderly patient population. The influence of age, sex, medical comorbidities, mental status, and preinjury level of function on postoperative function, complication rate and mortality remains unclear.[10–17]

Sherk et al[18] compared the outcome of internal fixation versus nonoperative treatment in a population of institutionalized senile patients with hip fracture. The mortality rate at 16 weeks after injury was more than 50% for the 45 patients managed nonoperatively. This mortality rate decreased to 28% for the 53 patients who underwent prompt surgical stabilization. Based on these findings, the authors concluded that operative management of hip fracture in the elderly, senile patient was preferable to nonoperative treatment and offered the best opportunity for surviving the injury.

In a retrospective analysis of operative versus nonoperative management in nonagenarians with hip fracture, Ooi et al[19] evaluated the outcomes of 84 patients over a 2-year period. The authors found that the complication rate for the patient cohort managed nonoperatively was higher (63%) than that seen in the cohort that underwent surgical stabilization (43%). Mortality rates at 1 and 2 years postinjury were higher in the patients treated nonoperatively (45% and 58%, respectively) compared with those seen for the operatively managed cohort (30% and 41%, respectively). Additionally, surgical management led to a significantly higher percentage of patients capable of independent ambulation after treatment compared with those who were treated nonoperatively.

Accepted for publication March 4, 2008.

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Kenneth A. Egol receives research support from Stryker, Biomet, and Synthes. He is an unpaid consultant for Exachtech and is on the medical advisory board for Surgix Inc. with stock options. Eric Strauss has no financial disclosures to report.

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TIMING OF SURGERY

A common treatment principle in the management of geriatric hip fractures is the belief that operative repair should be performed as quickly as possible after the patient is admitted to the hospital.[20–22] Most studies have shown an association between operative delay of more than 24–48 hours and a higher 1-year mortality rate. However, it is important to acknowledge that there is an important balance between optimization of medical issues and expeditious surgical management (Table 1).

Kenzora et al[14] retrospectively evaluated the morbidity and mortality rates for 399 elderly patients with hip fracture who underwent open reduction and internal fixation over a 6-year period. The authors found that 34% of the 96 patients who underwent surgery within 24 hours of admission died within 1 year. This was a significantly higher 1-year mortality rate than that seen in the patients who were operated on between postadmission days 2 and 5. Patients in whom the operative repair was delayed more than 5 days due to 1 or more uncontrolled medical comorbidities had a 1-year mortality rate of 35%. Based on their findings, the authors concluded that there was no increase in mortality with a surgical delay of less than 1 week. Additionally, they recommended that surgery be delayed for at least 24 hours to medically optimize the elderly patient with fracture and to remove any potential harmful effects of immediate surgical intervention.

In a retrospective analysis of 300 hip fractures, Sexson and Lehner evaluated the factors affecting mortality rates 1 year after injury.[23] The authors found that for relatively healthy patients ($\leq$2 medical comorbidities), there was a significantly higher survival rate at 1 year when operative fixation occurred within 24 hours compared with those whose surgical treatment was delayed. However, for patients with $\geq$3 medical comorbidities, there was a poorer survival rate when surgery was performed within 24 hours compared with those operated on after 24 hours. The authors concluded that healthy patients with hip fracture should undergo operative fracture fixation within 24 hours of hospital admission and less healthy patients should be medically optimized before surgery without adding increased mortality risk from the delay.

Zuckerman et al[22] prospectively followed 367 geriatric hip fractures for a 1-year period after injury. All the patients in this cohort were at least 65 years old, cognitively intact, living at home, and were independent ambulators before injury. The authors found that a surgical delay of more than 2 days after hospital admission doubled the 1-year risk of mortality. This increased risk remained significant after the data were controlled for patient age, sex, and number of comorbidities. The authors concluded that operative delay of more than 48 hours was an important predictor of mortality within 1 year of the injury, and optimally, surgical intervention should occur within 2 calendar days of hospital admission.

Hamlet et al[13] retrospectively examined 171 intertrochanteric or femoral neck fractures in 168 patients with a mean follow-up of 33 months. They noted that the overall mortality rate was 14% at 1 year, 26% at 2 years, and 33% at 3 years postinjury. There was a significant difference in 3-year mortality rates between patients having surgery within 24 hours (20%) and those who experienced a delay in operative treatment (50%). Further analysis demonstrated that patients operated on within 24 hours of admission had a significantly lower mortality rate than those whose surgery was delayed regardless of preoperative American Society of Anesthesiologists' (ASA) classification.

Doruk et al[4] divided their population of 65 elderly patients with hip fracture into an early cohort (operated on within 5 days of admission) and a late cohort (operated on after 5 days of admission). They found that the patients in the late cohort had a longer hospital stay; a longer time to the recovery of weight bearing; lower activities of daily living scores at 1, 3, and 6 months postoperatively; and higher mortality rates at 1 month and 1 year postoperatively compared with the patients in the early cohort. Based on these findings, the authors concluded that their data supported the policy of early operative intervention for geriatric hip fractures.

TABLE 1. Timing of Surgery

Study	No. Patients/Hip Fractures	Time to Operative Repair	Findings
Kenzora et al (1984)[14]	399 patients	96 patients operated on <24 hours	1 year mortality rate of 34%, which was significantly higher than that seen in patients operated on 2–5 days after injury
Zuckerman et al (1995)[22]	367 patients	>48 hours	Risk of mortality nearly doubles compared with those operated on within 2 hospital days (hazard ratio of 1.76)
Hamlet et al (1997)[13]	168 patients/171 hip fractures	>24 hours	3-year mortality rate of 50% compared with 20% rate for patients operated on within 24 hours
Doruk et al (2004)[4]	65 patients	>5 days	Late cohort had longer hospital stay, longer time to functional recovery, lower activities of daily living scores at 6 months post-op, and higher mortality at 1 year
Orosz et al (2004)[24]	1206 patients	>24 hours	Cohort had significantly less pain, shorter hospital stay, and a lower incidence of post-op complications; no difference in function or 6-month mortality rate
Gdalevich et al (2004)[26]	651 patients	>48 hours	1-year mortality rate of 25.7% compared with a rate of 14.1% for patients operated on within 48 hours
McGuire et al (2004)[28]	18,209 patients	>48 hours	Delay led to a 17% higher chance of mortality by postoperative day 30
Moran et al (2005)[27]	2660 patients	>4 days	Increased risk of mortality at 90 days and 1 year compared with those operated on within 4 days (hazard ratios of 2.25 and 2.4, respectively)

In a prospective evaluation of 1206 patients older than 50 years with a hip fracture, Orosz et al[24] examined the association of timing of surgical repair with function and overall mortality. The authors demonstrated that surgery within 24 hours of injury was not associated with improved function or mortality at 6 months of follow-up. However, early operative intervention resulted in significantly less pain, a shorter hospital stay, and a lower incidence of major postoperative complications. Similar findings were reported in a recent prospective evaluation of 3628 geriatric hip fractures by Siegmeth et al.[25] The authors found a significant increase in the length of hospital stay when surgical management was delayed for more than 48 hours.

Gdalevich et al[26] reported on 651 consecutive hip fractures in patients older than 60 years in an analysis of the impact operative delay had on 1-year mortality rates. Among the patients who were operated on within 48 hours of the injury, there was a 1-year mortality rate of 14.1%. This was significantly lower than the 1-year mortality rate seen in patients who were operated on after more than 48 hours (25.7%). There was no significant relationship between operative delay and the incidence of postoperative complications in this cohort.

In a prospective observational study of 2660 patients with hip fracture, Moran et al[27] demonstrated an overall postoperative mortality rate of 9% at 30 days, 19% at 90 days, and 30% at 1 year. Patients with medical comorbidities causing a delay in surgery had 2.5 times the risk of death within 30 days compared with those declared fit for immediate surgical intervention. Mortality was not increased in relatively healthy patients when operative fixation was delayed for up to 4 days. However, surgical delay of more than 4 days significantly increased the risk of mortality at 90 days and 1 year after injury.

McGuire et al[28] in a retrospective review of 18,209 geriatric patients with hip fracture reported a similar relationship between surgical delay and mortality rates. The authors found that cases in which operative intervention was delayed for more than 2 days had mortality rates that were significantly higher than those in cases in which surgical fixation was performed within 48 hours. Further analysis demonstrated that surgical delay was an independent risk factor for mortality after hip fracture in patients older than 65 years.

Shabat et al[29] performed a retrospective cost analysis of 191 patients treated for hip fracture. Fifty-one patients underwent surgery within 24 hours, 37 within 2 days, 38 within 3 days, 28 within 4 days, and 37 within 5 days. Length of stay in this study was shortest for patients operated on day 2 or 3. However, an increased incidence of major complications was found in patients operated on between days 2 and 5 after admission. With respect to the cost analysis, the authors found that spending more resources early (<48 hours) in the hospital admission was more cost-effective than delaying surgery (>72 hours).

Based on the available data in the literature, we recommend operative treatment within 48 hours for the majority of patients with hip fracture. In the subpopulation of patients with more than 3 medical comorbidities, we prefer to delay surgical intervention until medical optimization is achieved, ideally occurring within 4 days of hospital admission.

PREOPERATIVE TRACTION

Preoperative traction for patients awaiting hip fracture surgery has been used in an effort to reduce pain, limit fracture displacement, and reduce the force required for intraoperative fracture reduction.[30,31] The application of preoperative traction, whether skeletal traction or skin traction, has been associated with various complications ranging from pressure sores and nerve compression to the development of blisters secondary to mechanical shearing forces applied to the skin. Recent studies have evaluated the efficacy of preoperative traction in the patient population with hip fracture.

In a randomized controlled trial including 120 geriatric patients with hip fracture, Jerre et al[32] found that skin traction had no benefit with respect to pain control compared with no treatment in the preoperative period. Five of the 50 patients randomized to the treatment group (10%) developed pressure sores secondary to skin traction. In 2 similar studies, Anderson et al[33] and Needoff et al[34] each found that the application of skin traction preoperatively provided no benefit with respect to level of pain, analgesic requirement, or ease of operative fixation compared with no treatment. Rosen et al[31] compared preoperative skin traction with the placement of a pillow under the injured extremity in 100 consecutive patients with hip fractures. The authors found that the patients treated with a pillow had significantly less pain and a lower analgesic requirement than those who were placed in preoperative skin traction.

Based on data from the available literature, we recommend against the use of preoperative traction in the geriatric patient population with hip fracture.

MEDICAL EVALUATION

Advanced age is not an independent risk factor for complication after surgery, but the geriatric patient with hip fracture tends to have a number of coexisting medical conditions that impact surgical risk. Cardiac disease including coronary artery disease and hypertension, pulmonary disease, endocrine disease including diabetes, neurological disease, and genitourinary and gastrointestinal conditions all must be evaluated to optimize the patient's outcome. This increases the importance of the roles the internist and anesthesiologist play in the successful perioperative management of this potentially complex patient population.

Nettleman et al[35], in a retrospective analysis of 390 geriatric patients with hip fracture, evaluated the relationship between specific medical comorbidities as predictors of postoperative mortality. The authors found that congestive heart failure, angina, and chronic pulmonary disease were all independent risk factors for mortality at 30 days after injury. Sixty-three percent of inpatient mortalities in this investigation were attributable to cardiovascular events. These findings support the importance of recognizing and optimizing medical pathology in the perioperative period.

The ASA developed a classification system to divide patients into 5 categories as an indicator of their anesthetic and surgical risks. ASA class I is reserved for normal and healthy patients with minimal additional anesthetic or surgical risk. ASA class II describes patients with mild systemic disease who are adequately controlled with no functional limitations.

ASA class III is for patients with moderate-to-severe systemic disease that does have an impact on their function, such as stable angina or diabetes with systemic sequelae. ASA class IV describes a patient with severe systemic disease that poses a potential threat to life during the planned surgical intervention. Finally, ASA class V designates patients who are moribund with a substantial risk of death within 24 hours.

Michel et al[36] reported on 114 geriatric patients with consecutive hip fractures with a mean age of 82.4 years. The authors divided the study patients into 2 categories based on ASA classification, ASA I–II and ASA III–IV. Patients with significant systemic disease (ASA III and IV) demonstrated 1-year mortality rates that were 9 times higher than that seen in patients with less severe medical comorbidities (ASA I and II). The authors concluded that ASA classification was a strong predictor of mortality after hip fracture.

In a retrospective evaluation of 836 patients with hip fracture older than 65 years, Richmond et al[37] attempted to identify factors predictive of increased postinjury mortality. The authors found that mortality risk was highest within the first 3 months after injury. Patients in the 65- to 84-year-old subcategory had a higher mortality risk at each follow-up time point than that seen in patients older than 85 years. For these younger patients with hip fracture, ASA classification was predictive of increased mortality risk, with ASA class III and IV imparting a significant increased risk of death after hip fracture.

Browner et al,[38] in a prospective cohort study of 474 men between the ages of 38 and 89 years (mean age of 68 years), demonstrated that comorbidity is a predictor of postoperative mortality in patients undergoing noncardiac surgery. The authors demonstrated that a history of hypertension, a severely limited activity level, and a reduced renal function (low creatinine clearance) were all independently associated with an increased risk of postoperative mortality. The in-hospital mortality rate in patients with 2 or more of these risk factors was nearly 8 times higher than that seen in patients with 0 or 1 risk factor.

The American College of Cardiology and the American Heart Association have developed guidelines for patients undergoing noncardiac surgery, including orthopedic procedures. Perioperative stress testing is indicated for patients with an unstable cardiac condition and those with either new onset angina or a change in the anginal pattern. Preoperative echocardiogram is recommended for patients with a history of angina pectoris and any condition in which there is a known decrease in left ventricular function. The more extensive workup required for older patients with hip fracture with known cardiac disease provides the anesthesiologist with important physiological information, enabling them to tailor the fluid balance and level of anesthesia in an effort to avoid intraoperative and postoperative complications.

In a retrospective evaluation of 8930 geriatric patients with hip fracture, Lawrence et al[39] reported on the incidence and outcomes of medical complications after hip fracture repair. In this large cohort, 1737 patients (19%) developed postoperative complications, of which cardiac and pulmonary complications were most frequent (8% and 4%, respectively). Other medical complications in this series included gastrointestinal bleeding (2%), venous thromboembolism (1%), and transient ischemic attacks or strokes (1%). Mortality rates at 30 days and 1 year were similar for patients developing cardiac and pulmonary complications (30 days: 22% and 17%, respectively, and 1 year: 36% and 44%, respectively). The highest mortality rates were seen in patients with multiple postoperative medical complications. Based on these findings, the authors concluded that although the majority of geriatric patients with hip fracture have no medical complications after hip fracture repair, those who develop complications have a poor postoperative prognosis. Additionally, this study highlights the importance of the continued involvement of the internist in patient management after hip fracture surgery.

With respect to determining the risk of postoperative pulmonary complication, important factors include a history of smoking, a history of chronic obstructive pulmonary disease, and low oxygen levels on arterial blood gas. The value of routine preoperative pulmonary function testing in pulmonary risk assessment remains controversial. Smetana[40] reviewed the importance of preoperative pulmonary function testing and found that the majority of studies in the medical literature suggest that a forced expiratory volume (FEV_1) or forced vital capacity (FVC) $<70\%$ of the predictive value and an FEV_1/FVC ratio $<65\%$ are associated with an increased risk of postoperative pulmonary complications. However, a critical appraisal of 22 studies evaluating the predictive value of preoperative spirometry found methodological flaws in every investigation.

Based on the available evidence, we recommend early involvement of both the internist and the anesthesiologist in the assessment of the geriatric patient with hip fracture, in an effort to identify those at risk for perioperative and postoperative complications. Further cardiac and/or pulmonary workup should be dictated by the patient's history and the opinion of the medical team.

ANESTHESIA

Currently, no consensus exists as to which is the best method of anesthesia employed in hip fracture surgery. The choice of anesthesia is typically based on the preferences of the patient and anesthesiologist, and the patient's medical status. For cases in which general anesthesia is used during operative fracture repair, induction is a crucial time. Slow circulation time may result in overdose, low intravascular volume can lead to hypotension, and cardiac disease can present as ischemic electrocardiogram changes or arrhythmias. Factors especially important in managing the geriatric patient with hip fracture undergoing general anesthesia include decreasing the dose of induction agents and having vasopressors on hand in the event of hypotension. There is recent evidence that for hip fracture surgery, general anesthesia with controlled hypotension may reduce intraoperative blood loss.[41] Proponents of regional anesthetic techniques believe that spinal–epidural anesthesia for hip fractures leads to better oxygenation in the early postoperative period and lower incidence of DVT compared with general anesthesia.[41] However, these advantages may come at the expense of an increased magnitude and frequency of intraoperative hypotensive episodes.

Gilbert et al[6] evaluated the effects of anesthetic technique on the long-term outcome of 741 elderly patients

after hip fracture repair. No significant difference was seen in the 2-year mortality rate or in the incidence of postoperative complications for patients managed with general anesthesia compared with those who received spinal anesthesia. Patients who received general anesthesia demonstrated slightly better ambulatory function at the 2-year follow-up time point than those who received spinal anesthesia. Based on these findings, the authors concluded that general anesthesia was at least as efficacious as spinal anesthesia and possibly better with respect to ambulatory status.

In a meta-analysis of 15 randomized trials that compared morbidity and mortality associated with general or regional anesthesia for patients with hip fracture, Urwin et al[42] demonstrated a reduced 30-day mortality rate and a lower incidence of DVT in the regional anesthesia group. Additionally, there was a trend toward a lower incidence of postoperative myocardial infarction, confusion, and postoperative hypoxia with regional anesthesia. Patients in the general anesthesia group demonstrated a trend toward lower incidences of cerebrovascular accident and intraoperative hypotension. The authors concluded that their analysis showed marginal advantages for regional anesthesia compared with general anesthesia for patients with hip fracture.

Parker et al[43], in a Cochrane review of 22 trials involving 2567 geriatric patients with hip fracture, pooled data from 8 trials to compare outcomes after general and regional anesthesia. The authors found that regional anesthesia was associated with a mild reduction in the incidence of DVT and had a lower mortality rate at 1-month post-op. However, there was no significant difference in 3-month mortality rates between the 2 anesthesia methods. The authors felt that based on the available data, there was insufficient evidence to determine the superiority of general versus regional anesthesia.

Koval et al[44] observed 631 patients older than 65 years who were ambulatory, home dwellers, and cognitively intact. In this cohort, 354 patients received general anesthesia and 277 patients received regional anesthesia. No differences were found with respect to length of stay, recovery of ambulatory ability, or percent functional recovery between the 2 groups at 3, 6, or 12 months of follow-up.

Lateral femoral cutaneous and femoral nerve blocks have been successfully used for the operative management of femoral neck fractures, but current opinion states that these peripheral nerve blocks are inadequate anesthesia for surgical repair of intertrochanteric fractures. Some authors have advocated the use of lumbar plexus blocks for hip fractures in patients with severe cardiopulmonary compromise,[45] but there is limited evidence as to the efficacy of this technique.

DVT PROPHYLAXIS

Clinical risk factors for venous thrombosis include advanced patient age, previous thromboembolism, malignancy, congestive heart failure, prolonged recumbency/paralysis, obesity, and deep venous system disease.[46–49] Patients sustaining a lower extremity fracture are also at an increased risk. Depending on the study and the screening method used, rates of DVT after hip fracture range from 30% to 60%, with a 30%–36% incidence of proximal DVT.[50] The frequency of pulmonary embolism after hip fracture ranges from 4.3% to 24% in the orthopedic literature, with the incidence of fatal PE reported as 0.5%–12.9% of cases.[50]

Thrombi limited to the veins of the calf are rarely associated with the development of pulmonary embolism. However, most proximal DVTs represent extension from the calf venous system and are at an increased risk for embolization. Currently, there are 2 approaches employed in the prevention of fatal PEs. The first approach involves early detection of subclinical venous thrombosis through screening of high-risk patients with signs and symptoms indicative of potential DVT and subsequent anticoagulant treatment when a thrombosis is discovered. The second approach involves primary prevention through the use of pharmacological and mechanical prophylaxis. Recently, there have been a number of trials investigating the role and type of DVT prophylaxis used in populations with hip fracture (Table 2).

In 2000, the Pulmonary Embolism Prevention Trial Collaborative Group[51] published the results of a randomized controlled trial including 13,356 patients with hip fracture examining aspirin versus placebo for DVT prophylaxis. The authors found that aspirin significantly reduced the incidence of symptomatic DVT by 30% and PE by 43% compared with placebo. Patients treated with aspirin prophylaxis had a higher rate of postoperative blood transfusion than those in the control group, but mortalities associated with bleeding episodes were similar between groups. Based on these findings, the authors concluded that aspirin reduces the risk of PE and DVT by at least one-third throughout the period of increased perioperative risk and should be given routinely in populations with hip fracture.

Ennis,[50] in a series of 1000 consecutive hip fractures, compared the efficacy of aspirin prophylaxis versus low–molecular weight heparin (enoxaparin). In the aspirin cohort, there were 3 cases of DVT (2 distal and 1 proximal) and 1 case of fatal PE. The enoxaparin cohort had 2 cases of proximal DVT and no case of PE. There was a slight increase in the incidence of minor bleeding complications with low–molecular weight heparin (5.7% vs 3.1%). The authors believed that their data, coupled with the short half-life, predictable pharmacokinetics, and favorable safety profile of enoxaparin, make low–molecular weight heparin an attractive pharmacological method of DVT–PE prophylaxis for the population with hip fracture.

In a Cochrane review of different methods for thromboprophylaxis after hip fracture surgery, Handoll et al[52] compiled data from 31 clinical trials covering 2958 cases. Based on the pooled data, the authors found that unfractionated and low–molecular weight heparin protect against the development of lower extremity DVT. However, there was insufficient evidence to confirm a protective effect against the development of pulmonary embolism. Mechanical methods of prophylaxis with foot or calf pumps provide significant protection against the development of DVT and PE and reduce overall mortality, but compliance remains a problem. Although different prophylaxis techniques are effective in preventing thrombotic complications after hip fracture surgery, there are still insufficient data in the orthopedic literature to form a consensus protocol with regard to prophylaxis.

Turpie et al[53] performed a meta-analysis of 4 multicenter randomized trials that compared fondaparinux (factor Xa

TABLE 2. DVT Prophylaxis

Study	No. Patients/Hip Fractures	Prophylaxis Agent Studied	Findings
Pulmonary Embolism Prevention Trial Collaborative Group (2000)[51]	13,356 patients	Aspirin vs placebo	Aspirin significantly reduced incidence of symptomatic DVT by 30% and PE by 43% compared with placebo
Turpie et al (2002)[53]	7344 patients	Fondaparinux (factor Xa inhibitor) vs enoxaparin (low–molecular weight heparin)	Fondaparinux significantly reduced the incidence of DVT (6.8%) compared with enoxaparin (13.7%) by post-op day 11
Handoll et al (2002)[52]	Cochrane review of 31 clinical trials	Unfractionated heparin, low–molecular weight heparin, and mechanical prophylaxis	Heparins provide significant protection against DVT; insufficient evidence to confirm protection against PE; mechanical prophylaxis is protective but compliance is problematic
Ennis (2003)[50]	1000 patients	Aspirin vs low–molecular weight heparin (enoxaparin)	Aspirin group had 3 cases of DVT and 1 PE; enoxaparin group had 2 cases of DVT and no PE; slight increase in risk of post-op bleeding complications with enoxaparin
Eriksson and Lassen (2003)[54]	656 patients	Fondaparinux for 6–8 days vs fondaparinux for 1 month post-op	Extension of prophylaxis reduced incidence of DVT from 35% to 1.4%

DVT, deep venous thrombosis; PE, pulmonary embolus.

inhibitor) with enoxaparin in 7344 cases of hip fracture. The authors found that fondaparinux significantly reduced the incidence of venous thromboembolism by postoperative day 11 (6.8%) compared with that seen with enoxaparin (13.7%). Major bleeding events occurred with a higher frequency in the fondaparinux group; however, the incidence of clinically relevant bleeding (leading to death or reoperation) did not differ between the treatment groups. Based on these findings, the authors concluded that fondaparinux showed a major benefit over enoxaparin, leading to an overall risk reduction of venous thromboembolism of greater than 50%.

In a double-blind multicenter trial of 656 hip facture patients, Eriksson and Lassen[54] evaluated the benefit of extending thromboprophylaxis to 1 month post-op. Extension of fondaparinux prophylaxis past the standard 6–8 days of treatment reduced the incidence of venous thromboembolism compared with placebo from 35% to 1.4%. Although there was a trend toward a higher frequency of bleeding episodes in the fondaparinux group, there were no differences between the treatment groups with respect to clinically relevant bleeding. The authors concluded that extension of thromboprophylaxis for 3 weeks after hip fracture surgery reduced the risk of venous thromboembolism by 96% and was well tolerated by the treated patient population.

At the present time, there remains a lack of consensus with respect to the optimal protocol for venous thromboembolism prophylaxis, with the literature supporting a number of different options. At our institution, for patients without contraindications, we provide both chemical and mechanical DVT prophylaxis with low–molecular weight heparin (30 mg subcutaneously q12 hours) and foot pumps.

PAIN MANAGEMENT

Effective pain control in the elderly patients with hip fracture is more complex than in younger patient populations. Factors that contribute to this complexity include impaired cognition, medical comorbidities, drug interactions, and problems with appropriate dosing. Decreased renal function leading to slower metabolism and excretion may result in greater peak drug levels and longer durations of action in this geriatric population. Supratherapeutic analgesic levels may lead to postoperative delirium and respiratory depression. In response to these potential complications, it is not uncommon for the geriatric patient with postoperative hip fracture to be undermedicated and in significant discomfort, impacting their ability to be mobilized. Assessment of postoperative pain may be difficult in the confused or noncommunicative patients. Nonverbal cues including restlessness, agitation, guarding or splinting, rapid blinking, facial expressions, and physiological changes such as tachycardia or increase in blood pressure, may represent the only means to identify significant discomfort.

In managing postoperative pain in the geriatric patients with hip fracture, it is important to make a baseline pain assessment. This should include a pain history including previous use of narcotic medications, evaluating the patient's mental status, and determining the extent of family involvement in the patient's care. Selecting a single pain intensity indicator (Mosby Pain Rating Scale and McGill Pain Questionnaire) for repeated use during the course of treatment facilitates continued assessment of the level of postoperative pain and allows for dosing adjustments for adequate analgesia.

Horgas and Tsai[55] evaluated the prescription and administration of analgesic medications to treat pain in a sample of 339 cognitively impaired, elderly nursing home patients. The authors found that cognitively impaired elderly patients were prescribed and administered significantly less analgesic medication than their more cognitively intact peers. These findings highlight the difficulties encountered with respect to assessing discomfort and providing adequate pain control in this complex patient population.

Similar findings were made in a review of 184 elderly patients with hip fracture by Adunsky et al.[56] The authors demonstrated that patients with postoperative hip fracture with cognitive decline or delirium received 53% and 34%, respectively, of the amount of opioid analgesics administered to cognitively intact patients. The authors concluded that pain control in the elderly patient population with hip fracture is

often suboptimal and that the adoption of a standardized protocol for pain management after hip fracture surgery may help in reducing the extent of this problem.

Morrison et al[57] evaluated the impact of postoperative pain on immediate postoperative outcomes and outcomes at 6 months after hip fracture in 411 consecutive cases. The authors found that for patients with higher pain scores at rest, there were significantly longer hospital stays and fewer shorter physical therapy sessions. Additionally, these patients were less likely to be ambulating by postoperative day 3 and had lower locomotion scores at 6-month follow-up. The authors believed that improved pain control may, in turn, decrease length of hospital stay, enhance functional recovery, and improve long-term functional outcomes.

Foss et al[58] examined the effect of postoperative epidural analgesia in a randomized trial of 60 geriatric patients with hip fracture. The authors compared 4 days of continuous postoperative epidural bupivacaine infusion with a morphine infusion and with placebo. Epidural analgesia provided superior pain control in the postoperative period and during physical therapy compared with controls. However, despite improved pain relief, scores for recovery of physical independence were not different between groups. Based on these findings, the authors concluded that the use of epidural analgesia provides a significant improvement over standard analgesic techniques with respect to postoperative pain control, but this improvement did not translate into enhanced rehabilitation.

Providing an appropriate analgesic regimen for the geriatric patients with hip fracture remains a difficult task. When possible, we recommend involving a pain management specialist to specifically tailor the analgesic type and dose. Frequent pain assessments using a standardized pain intensity indicator will help avoid undermedicating this patient population, facilitating postoperative rehabilitation.

PERIOPERATIVE ANTIBIOTICS

The use of prophylactic antibiotics in the perioperative period has become common practice for the majority of patients with hip fracture in an effort to decrease the incidence of postoperative infections and their associated morbidity.[59,60] Two recent meta-analyses evaluated the use of perioperative antibiotics in patients with hip fracture. Southwell-Keely et al[61] included data from 15 randomized controlled trials and found that antibiotic prophylaxis significantly reduced the incidence of wound infections compared with placebo. In their evaluation, the authors reported that 1 dose of intravenous antibiotics had equal efficacy to multiple-dose regimens. Similar results were reported by Gillespie and Walenkamp[62] in their meta-analysis of 22 studies including 8307 patients. The authors found that single-dose prophylaxis significantly reduced superficial and deep wound infections, urinary tract infections, and respiratory tract infections. Multiple-dose prophylaxis had a similar effect size on the incidence of deep wound infections, but significant effects on urinary tract and respiratory tract infections were not seen.

The literature supports providing antibiotic prophylaxis for all patients undergoing hip fracture surgery. At our institution, patients receive 1 g of intravenous cefazolin (600 mg of clindamycin if penicillin allergic) before skin incision followed by q8 hour dosing for a 24-hour period.

NUTRITIONAL SUPPLEMENTATION

At the time of hospital admission, the geriatric patient with hip fracture is often clinically malnourished.[63,64] Recent studies have demonstrated that patients with hip fracture have a higher incidence of protein energy malnutrition than age-matched controls, which may contribute to the development of postoperative wound complications, infection, and mortality.[64–68] The use of nutritional supplementation for the patient with hip fracture during their inpatient hospital stay has shown some promise in reducing complications and improving outcomes in the postoperative period. In a randomized controlled trial including 80 patients with hip fracture, Eneroth et al[64] found that patients who received nutritional supplements had lower complication rates and lower mortality rates compared with those who received the usual hospital diet.

Although further study is required, nutritional supplementation after hip fracture to counter the protein malnutrition often seen in this patient population may improve the overall outcomes.

PRESSURE ULCER PREVENTION

The development of pressure ulcers secondary to hip fracture–related immobilization can be a morbid complication in the perioperative period. In addition to vigilant nursing care with frequent turning, visual inspection, and topical Duoderm treatment, new specialty mattresses may limit the incidence of pressure ulcers. Hofman et al[69] showed in a prospective randomized trial that patients with hip fracture placed on an interface pressure–decreasing mattress (Comfortex DeCube mattress) had a significantly lower incidence of pressure ulcers (24% vs 68%) compared with those patients placed on a standard hospital mattress. Additionally, patients who developed pressure ulcers despite specialty mattress treatment had significantly less severe ulcers compared with those who developed on a regular hospital mattress. In a similar study comparing a viscoelastic pressure–reducing foam mattress with a standard hospital mattress, Gunningberg et al[70] found that the ulcers that developed in patients on the standard mattresses were more severe than those that developed on the specialty mattress.

When available, we believe that pressure-decreasing mattresses can be useful adjuncts in the geriatric patients with hip fracture whose mobility may be limited in the perioperative period.

MULTIDISCIPLINARY APPROACH

The American Association of Orthopaedic Surgeons' Task Force on Serving the Elderly Orthopaedic Patient recommended a collaborative multidisciplinary approach to the injured elderly patient. This approach includes input from the orthopedic surgeon, the geriatrician, the nursing staff, therapists, pharmacists, nutritionists, and pain management specialists.

Vidan et al[71] evaluated the impact of an early multidisciplinary intervention on length of stay, morbidity, mortality, and function after 319 cases of hip fracture in patients older than

65 years. The authors found that for patients whose care was organized and administered by a multidisciplinary geriatric intervention group, there was a lower inpatient mortality rate (0.6% vs 5.8% for the usual care cohort), a lower major complication rate (45.2% vs 61.7%), and a shorter hospital stay (16 vs 18 days). More patients in the intervention group achieved functional recovery at 3 months than that from the usual care cohort. Based on these findings, the authors concluded that multidisciplinary care in the treatment of the geriatric patients with hip fracture can significantly reduce complications and mortality after hip fracture.

REHABILITATION AND DISCHARGE DISPOSITION

The overall goal of rehabilitation for the elderly patient with hip fracture is a rapid return to mobility. At our institution, therapy sessions are initiated on postoperative day 1 and follow a structured protocol. Initially, the therapist performs an acute care evaluation including the diagnosis, procedure performed, and the weight-bearing status. In general, the patient with postoperative hip fracture is weight bearing as tolerated. This weight-bearing status is based on the fact that when allowed to weight bear as tolerated, patients with hip fracture tend to voluntarily limit the loading on the injured limb. In an evaluation of 60 geriatric patients with hip fracture, Koval et al[72] demonstrated that at 1 week postoperatively, patients placed approximately 51% of their normal weight-bearing load on their injured extremity. This increased to 87% of their normal weight-bearing load at 12 weeks.

On postoperative day 1, the therapy goal is for the patient to be able to ambulate 15 feet with moderate assistance. The distance increases to 20 feet with minimal assistance on postoperative day 2. By postoperative day 3, the therapy goal is ambulation for at least 40 feet with minimal assistance. A further increase in ambulation distance occurs on postoperative day 4 with the addition of stair climbing. The occupational therapist also plays an important role in the postoperative care of the geriatric patient with hip fracture, focusing on activities of daily living training and providing a detailed assessment of the patient's home environment to ensure a safe transition to independence.

Discharge planning should be a coordinated effort between the patient, the patient's family, and the social worker. The patient's ambulatory ability, social support network, and financial resources dictate the appropriate discharge disposition. Options include discharge home with outpatient therapy, transfer to an inpatient rehabilitation facility, and transfer to a skilled nursing facility or a subacute rehabilitation facility. Another option is referral to a day hospital where the patient may have a full day of therapeutic activity in a hospital setting but is able to return home at night.

SUMMARY

The elderly patient with hip fracture requires a treatment algorithm for a successful outcome. With the aging of the American population, the incidence of hip fractures is steadily increasing. An evidence-based assessment of the complex issues involved in managing the geriatric patient with hip fracture allows for educated choices to be made among a variety of options.

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