Thromboembolic Events Are Uncommon After Open Treatment of Proximal Humerus Fractures Using Aspirin and Compression Devices

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Abstract

Background Thromboembolic phenomena have long been recognized as a major cause of morbidity and mortality in hospitalized patients, especially those undergoing reconstructive surgery. We have been empirically treating patients with aspirin, early ambulation, and mechanoprophylaxis after operative management of proximal humerus fractures. However, we have not established the incidence of postoperative deep vein thrombosis and pulmonary embolism in this population.

Questions/purposes We determined the incidence of deep vein thrombosis and pulmonary embolism in patients having surgery for displaced proximal humerus fractures treated with our thromboprophylactic regimen.

Patients and Methods We prospectively followed 50 patients with proximal humerus fractures who underwent fixation with plate osteosynthesis ($n = 40$) or hemiarthroplasty ($n = 10$) between August 2005 and

December 2008. Deep vein thrombosis prophylaxis consisted of oral enteric-coated aspirin, pneumatic calf compression pumps, and early ambulation in all patients unless medically contraindicated. Color-flow Doppler ultrasound of the affected arm and both lower extremities was performed at a mean of 14 days (range, 7–21 days) postoperatively to evaluate for deep vein thrombosis. All patients clinically suspected to have suffered a pulmonary embolism underwent a CT angiogram.

Results We identified no patients with deep vein thrombosis or pulmonary embolism in this population.

Conclusions Deep vein thrombosis and pulmonary embolism are not uncommon after major reconstructive surgery about the shoulder in untreated patients. Our data suggest these events can be low after surgery for proximal humerus fractures followed by a thromboprophylactic regimen including aspirin, mechanical devices, and early mobilization.

Level of Evidence Level IV, therapeutic study. See Guidelines for Authors for a complete description of levels of evidence.

Each author certifies that he or she has no commercial associations (eg, consultancies, stock ownership, equity interest, patent/licensing arrangements, etc) that might pose a conflict of interest in connection with the submitted article.

Each author certifies that his or her institution approved the human protocol (#811544) for this investigation, that all investigations were conducted in conformity with ethical principles of research, and that informed consent for participation in the study was obtained. This work was performed at both Pennsylvania Hospital and Lankenau Hospital.

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Introduction

Thromboembolic phenomena have long been recognized as a major cause of morbidity and mortality in hospitalized patients, especially in the critically ill population [16]. Deep vein thrombosis (DVT) and pulmonary embolism (PE) are both manifestations, with a combined incidence approximating 117 per 100,000 and PE alone accounting for 69 per 100,000 [16]. Nearly 10% of patients with a DVT suffer a subsequent PE, and 10% of these are fatal [10].

Within the orthopaedic community, DVT and PE after lower-extremity fracture and arthroplasty have been

extensively researched. Symptomatic PE or DVT has been diagnosed in 1.3% to 1.6% of patients undergoing open treatment of hip fractures when provided postoperative prophylaxis [13, 14]. In elective lower limb arthroplasty, patients receiving prophylactic injectable antithrombotics suffered incidences of symptomatic DVT or PE of 1.3% after hip arthroplasty and 2.8% after knee arthroplasty [15].

More recently, data regarding venous thromboembolism after shoulder surgery have become increasingly available. A retrospective review of more than 300,000 arthroplasties in New York State identified a symptomatic DVT frequency of five per 1000 shoulder arthroplasties, 15.7 per 1000 hip arthroplasties, and 26.9 per 1000 knee arthroplasties [9, 17, 20]. The authors also identified a symptomatic PE frequency of 2.3 per 1000 shoulder arthroplasties, 4.2 per 1000 hip arthroplasties, and 4.4 per 1000 knee arthroplasties. Another retrospective review of all shoulder arthroplasties performed over a 20-year period at a single institution discovered an incidence of symptomatic PE of 0.173%. No fatal PEs were identified [17]. A more recent study prospectively evaluated 100 consecutive shoulder arthroplasties with four-limb Doppler ultrasound and diagnosed 13 DVTs [20]. In the same cohort, the incidence of symptomatic PE was 2%. Additionally, development of a DVT, and subsequent symptomatic PE, has been reported after arthroscopic superior labral repair [3].

Reports of the ranges of incidence of DVT and PE after surgery for proximal humerus fractures remain scarce. One retrospective study reported a rate of CT-confirmed, symptomatic PE after surgery for proximal humerus fractures of 5.1% [7]. Currently, objective clinical guidelines to help assess and manage DVT and PE risk after fixation of proximal humerus fractures do not exist.

This lack of guidelines unfortunately coincides with an increased incidence of fragility fractures over the last several decades [2]. Proximal humerus fractures are the third most common fracture in elderly patients [6], and the occurrence of these fractures appears to be increasing [12]. Fortunately, 80% of patients with proximal humerus fractures do not require surgery. In our center, we have been empirically treating patients with aspirin, early ambulation, and mechanoprophylaxis after operative management of proximal humerus fractures for several years. The essential question regarding the occurrence of DVT or PE postoperatively in this population remains unanswered.

Therefore, we sought to (1) prospectively identify the incidence of DVT and PE after the operative management of patients with displaced proximal humerus fractures treated with this aspirin-based thromboprophylaxis protocol and (2) identify the predisposing factors associated with postoperative DVT or PE.

Patients and Methods

We prospectively screened 68 patients with proximal humerus fractures who underwent fixation with plate osteosynthesis or hemiarthroplasty between August 2005 and December 2008 in accordance with an IRB-approved protocol. We included all patients older than 18 years and able to provide informed consent presenting with a displaced proximal humerus fracture that required operative treatment. We excluded patients with active cancer ($n = 2$), those who were nonambulatory, and those who had hypercoagulable states ($n = 2$), polytrauma ($n = 3$), major surgery within the prior 3 months ($n = 1$), oral contraceptive use ($n = 2$), preoperative treatment with chemical or mechanical venous thromboembolism prophylaxis ($n = 1$), medical contraindication to aspirin ($n = 7$), or inability to complete ultrasound examination within 4 weeks of surgery ($n = 2$). Patients prescribed 81 mg aspirin daily for cardiovascular prophylaxis were allowed to continue therapy through treatment. Patients taking higher doses for thromboprophylaxis were excluded. These exclusions were distributed among 18 patients. The remaining 50 patients were followed, underwent ultrasound monitoring for DVT, and were analyzed. The clinical outcome of interest in our study was defined as the presence or absence of a DVT or PE. The average age was 68.8 years (range, 29–92 years), and no patients were lost to followup.

Preoperatively, we recorded descriptive data, including age, sex, ethnicity, body mass index (BMI), and handedness (Table 1). Additionally, we recorded potential risk factors for thrombosis for all patients, including immobilization, presence of malignant disease, pregnancy, smoking, oral contraceptive use, previously diagnosed

Table 1. Patient characteristics

Variable	Number of patients
Gender	
Male	8
Female	42
Race	
White	41
Black	3
Hispanic	2
Other	4
Body mass index (kg/m^2)	
< 18.5	1
18.5–24.9	9
25–29.9	11
> 30	29
Dominant arm fractured	37 (74%)

Table 2. Potential risk factors for venous thromboembolism

Medical comorbidities	Number of patients
Diabetes	13
Cardiovascular disease	29
Renal disease	3
Peripheral vascular disease	3
Limited ambulator	1
Inflammatory arthritis	2
Tobacco use	5

hypercoagulable state, and medical comorbidities (Table 2). Using the Neer classification system [11], we classified the fractures as two-part ($n = 6$) (12%), three-part ($n = 28$) (56%), and four-part ($n = 16$) (32%).

A fellowship-trained shoulder and elbow surgeon performed all procedures through a standard deltopectoral approach with the patient in the semireclined, beach chair position, under general anesthesia. Of the 50 patients, 40 underwent fixation with plate osteosynthesis and 10 underwent hemiarthroplasty. The choice of implant and method of fixation was based on surgeon preference. Kendall sequential external pneumatic compression devices (Kendall Co, Boston, MA) were applied universally throughout the perioperative period.

After surgery, DVT prophylaxis consisting of oral enteric-coated aspirin, pneumatic compression pumps, and early ambulation was initiated in all patients unless medically contraindicated. Enteric-coated aspirin therapy consisting of 325 mg administered orally twice daily was initiated the evening of surgery and continued for 6 weeks. Seven patients did not undergo early ambulation due to difficulties with postoperative nausea and fatigue. Based on previous reports regarding shoulder arthroplasty and fracture fixation, the standard of care for all inpatients in our hospital system, and the standard of care in our shoulder and elbow practice, we did not believe it was appropriate to withhold postoperative thromboprophylaxis from any patients [4, 20]. Therefore, no control group was available.

Color-flow Doppler ultrasound of the affected arm and bilateral lower extremities was performed at a mean of 14 days postoperatively (range, 7–21 days) to evaluate for DVT. A screening surveillance Doppler ultrasound was not performed before surgery. All ultrasounds were performed according to the standard of care in our community by board-certified radiologists with experience in duplex color ultrasonography (Sonos 2000; Hewlett Packard, Andover, MA) with probes ranging from 4.5 to 7.5 MHz [1]. In the appropriate clinical setting, deviation from normal values in respiratory rate, oxygenation, arterial blood gas, and/or

Table 3. Perioperative data

Variable	Value
Time to operation (hours)	11 ± 4.0 (3–26)
Operative time (minutes)	118 ± 17.4 (92–143)
Total anesthesia time (minutes)	172 ± 27.2 (137–191)
Time to ambulation after surgery (hours)	12 ± 6.4 (3–18)
Length of hospital stay (days)	2.7 ± 2.3 (1–8)

Values are expressed as mean $\pm$ SD, with range in parentheses.

EKG was investigated with spiral CT angiogram to ensure detection of PE.

Postoperatively, all patients were treated with similar restrictions and physical therapy. Patients were placed in a sling and encouraged to start early passive ROM exercises. Initiation of passive ROM exercises (pendulums and passive forward elevation and external rotation) typically was started within the first 3 postoperative days. Patients began active ROM exercises at approximately 4 to 6 weeks postoperatively after radiographic evidence of early osseous healing was confirmed. Strengthening or resistive exercises were begun approximately 10 to 12 weeks after surgery.

Patients were seen postoperatively at a minimum of 1 week, 6 weeks, 3 months, 6 months, and 1 year and clinically monitored for the development of any symptomatic DVT or PE.

Time to operation, operative time, anesthesia time, time to ambulation, length of hospital stay, and any associated thromboembolic complication occurring during the index hospitalization were recorded. Time to ambulation was defined as the time between the conclusion of surgery and the first documentation of patient ambulation. This was recorded from nurses' documentation in the postanesthesia care unit and the inpatient setting (Table 3). No specific ambulation protocol was employed, other than to encourage all patients to mobilize as soon as they were safely able. Discharge was typically to home (30 patients), but 20 patients were discharged to either an inpatient rehabilitation or a skilled nursing facility.

Of note, two of the 18 patients excluded from the study developed a thrombus. One patient with a previously undiagnosed malignancy developed a symptomatic PE 4 weeks after plate osteosynthesis. This symptomatic, nonfatal pulmonary embolus was documented by spiral CT scan. A second patient with simultaneous operatively treated bilateral proximal humerus fractures treated with open reduction and internal fixation developed a symptomatic DVT. This was a proximal DVT of the common femoral vein diagnosed on ultrasound and treated without further incident.

Results

None of the 50 patients included in the study developed a postoperative DVT or PE. No hematomas or infections requiring aspiration or surgical irrigation and débridement developed in our patient population. In addition, no episodes of gastrointestinal bleeding were identified in any patients either in the perioperative period or during the 6-month postoperative period. While six patients required transfusions perioperatively, four were transfused intraoperatively and two were transfused within 24 hours of surgery, with subsequent appropriate normalization of their hemoglobin.

Due to the lack of the clinical findings of interest and our small sample size, we could not determine whether any of the specific risk factors (demographics/comorbidities), operative treatment, or fracture patterns contributed to DVT or PE.

Discussion

Although extensive research has been reported on thromboembolic phenomena after hip and knee arthroplasty, instructive data concerning DVT and PE after the operative treatment of proximal humerus fractures remain scarce [5, 8, 13, 21]. As the general population ages and proximal humerus fractures become increasingly prevalent, information regarding the risks of treatment is essential for informed decision making by clinicians. We therefore determined the incidence of DVT and PE after the operative management of patients with displaced proximal humerus fractures treated with an aspirin-based thromboprophylaxis protocol and identified potential risk factors predisposing to postoperative DVT or PE.

There are several limitations to our study design. First, due to finite resources, we reported on a relatively small number of patients. Second, Doppler ultrasound was only performed at one postoperative time point and we performed the examination only on the ipsilateral side. In a more favorable funding environment, resources would be available to evaluate a larger cohort of patients, include the nonoperative upper extremity, and provide ultrasonography at a preoperative time point and two or more postoperative intervals. Third, inclusion of a control group of patients with proximal humerus fractures treated nonoperatively is highly desirable and could serve to elucidate the background rate of thrombosis in this population apart from the risk attributable to surgical management. Perhaps the most informative design would be a large, randomized, controlled trial of operatively and nonoperatively treated patients to investigate the efficacy of a prophylactic

protocol compared with no chemoprophylaxis. This would obviously be a costly study but should certainly be considered as a future direction. The American Academy of Orthopaedic Surgeons Glenohumeral Osteoarthritis Physician Work Group made a similar call for studies regarding prophylaxis after total shoulder arthroplasty in their recent report [18]. We certainly echo that call in this patient population. Regarding prophylaxis, we have no documentation of patient adherence to either the prescribed use of pneumatic compression devices or aspirin. Clearly, this is a limitation not only of our study but also of patient care in the general case. Finally, ultrasound was used as the method of diagnosis, and while it is inexpensive, noninvasive, and able to provide reproducible results, ultrasonography is notoriously operator dependent and may fail to detect central thrombosis located directly beneath the clavicle or in the pelvis. Because of these limitations, we recognize the possibility that our findings may in fact underestimate the true incidence of DVT after the surgical treatment of proximal humerus fractures. Alternatively, but perhaps of equal importance, this method may overestimate the incidence of clinically important DVT. The question of what constitutes a DVT or PE requiring anticoagulant therapy is an important one, but it is beyond the scope of this discussion.

Given the lack of reports regarding proximal humerus fractures, we compare our results with those from studies of elective shoulder arthroplasty. The 0% incidence of DVT in our study is lower than the general population incidence of DVT as reported in a recent meta-analysis [4]. The authors found a background rate in the general population of 0.05% for persons aged 30 to 49 years and 0.2% for persons aged 70 to 79 years. Idiopathic thrombi accounted for 40% of all cases. Our reported rate was also lower than the 10.3% incidence of DVT after hip arthroplasty [19]. Our 0% incidence of PE is comparable to the 2% rate after shoulder arthroplasty reported by Willis et al. [20] and the 0.173% rate reported by Sperling and Cofield [17]. Additionally, our PE rate compares favorably with the previously published PE rate of 5.1% after operative treatment of proximal humerus fractures [7]. Unfortunately, that retrospective report did not address DVT. Finally, our results compare favorably with recent reports of patients undergoing total shoulder arthroplasty receiving prophylaxis with aspirin and mechanical devices. These investigators found a postoperative DVT rate of 2.2% with no PEs (Table 4). The Pulmonary Embolism Prevention (PEP) trial has demonstrated the effectiveness of aspirin for reducing DVT and PE after hip fracture [13]. Since that study only evaluated symptomatic thromboembolic events, comparison to this or similar studies incorporating screening ultrasound of all patients is difficult.

Table 4. Selected literature review of venous thromboembolism

Diagnosis/thromboprophylaxis	DVT (%)	PE (%)
Proximal humerus fracture/untreated [7]		5.1
Proximal humerus fracture/ASA [this study]	0	0
TSA/untreated [20]	13	2
THA/ASA [5]	6.4	0.6
TKA/ASA [8]	9.3	0.3
Hip fracture/heparin [21]	7.2	0.9

DVT = deep vein thrombosis; PE = pulmonary embolism; ASA = acetylsalicylic acid (aspirin); TSA = total shoulder arthroplasty.

We favor our protocol based on the published rate of thrombotic events after both elective shoulder arthroplasty and operative management of proximal humerus fractures and the success of the PEP trial in reducing symptomatic DVT and PE after hip fracture with 35 days of oral aspirin therapy [7, 13, 20]. The lack of randomized studies in our population of interest drives us to make use of studies in related but dissimilar populations to provide a treatment rationale.

Surgeons should be aware of the growing evidence that DVT and PE are not uncommon after major reconstructive surgery about the shoulder. The data presented here demonstrate, with a thromboprophylactic regimen including aspirin, mechanoprophylaxis, and early mobilization, the incidence of DVT and PE can be low after the operative treatment of proximal humerus fractures. Randomized, controlled trials of thromboprophylactic protocols for patients with surgically treated proximal humerus fractures are desperately needed to define the safest and most effective means of treating these patients.

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