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One-Year All-Cause Mortality of Patients Diagnosed as Having In-Hospital Pulmonary Embolism After Modern Elective Joint Arthroplasty Is Low And Unaffected By Radiologic Severity

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A B S T R A C T

Background: We studied the 1-year complication rate of patients diagnosed as having a pulmonary embolism (PE) after elective total hip arthroplasty (THA) and total knee arthroplasty (TKA) surgery and the distribution of emboli in the pulmonary circulation, and determined if a relationship exists between the location of the PE and age, gender, body mass index, preoperative predisposing factors, American Society of Anesthesiology classification, type of surgery, prophylaxis, hospital stay, transfer to a higher level of care, and mortality.

Methods: Two hundred sixty-nine patients who developed an in-hospital PE proved by computed tomography pulmonary angiography after elective THA or TKA between 2005 and 2012 were studied.

Results: The most proximal location of the emboli was central in 62, segmental in 139, and subsegmental in 68. Nineteen patients (7%) developed a bleeding complication during PE treatment. Twenty-nine patients (11%) were readmitted during the first year. Two patients (0.74%) died: one had a segmental PE after TKA. He died 11 months after surgery due to an autopsy-proven sepsis. The second patient developed a segmental PE after THA. She was anticoagulated, developed an intracranial bleed, and died 8 months after surgery. Multivariate analysis showed that demographic variables, American Society of Anesthesiology class, preoperative comorbidities (with the exception of arrhythmia), and the presence of preoperative predisposing factors had no effect in the location of the PE.

Conclusion: The 1-year mortality rate of these patients is low. Death can be caused by bleeding complications secondary to anticoagulation or by unrelated conditions. This information may aid clinicians while counseling patients who developed a PE after surgery, particularly those with small subsegmental emboli.

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The development of a potentially life-threatening pulmonary embolism (PE) is of outmost concern for surgeons specializing in total hip and knee arthroplasty (THA and TKA), based on the historically high rates of postoperative PE and fatal PE [1–4]. These facts reported by the pioneers of joint arthroplasty surgery nearly half a century ago have made a profound impact in the clinical thinking of anesthesiologists, surgeons, and internists caring for patients. In the event of an unexpected death, most orthopedic surgeons will believe that death was a consequence of a potentially preventable PE.

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However, in the early era of THA, the average duration of the operation was 2.4 hours, blood loss was 1650 mL, and the volume of blood transfused was 1144 mL. Prophylactic anticoagulation with warfarin started 5 days after the operation; patients were managed with bed rest for an average of 1 week and were discharged at an average of 3 weeks after surgery [5]. This contrasts with our current experience, with an average duration of surgery of 76 minutes, average hematocrit drop at discharge of 6.3%, and requirement of homologous blood in only 6% of patients [6]. Patients are mobilized the day of surgery or the day after surgery and discharged at an average of 3 to 4 days after the operation [6–8].

The substantial advancements in preoperative risk stratification, anesthesia, surgical, and postoperative care techniques coupled with advancements in the understanding of the pathogenesis and prevention of venous thromboembolism (VTE) have resulted in progressive reductions in the rates of deep vein thrombosis (DVT) and PE after elective joint arthroplasty surgery [9].

Multidetector computed tomography pulmonary angiography (CTPA) has become the method of choice for imaging the pulmonary

vasculature when PE is suspected, and its use has increased. It allows the detection of small emboli that would have otherwise remained undiagnosed [10,11].

We underwent an analysis of all patients who had a postoperative PE diagnosed by CTPA at our institution attempting to answer the following research questions:

1. What are the in-hospital and after discharge, 1-year complication, readmission, and mortality rates of patients diagnosed as having an in-hospital PE after elective THA and TKA?
2. What is the distribution of emboli within the pulmonary circulation and how frequent is the concomitant presence of a DVT?
3. Is there a relationship between the location of the PE and preoperative, intraoperative, and postoperative factors including age, gender, body mass index (BMI), presence of preoperative predisposing factors, American Society of Anesthesiology (ASA) classification, type of surgery, type of prophylaxis, total hospital stay, total stay in postanesthesia care unit (PACU), likelihood of transfer to a higher level of care, morbidity, and mortality?

Materials and Methods

All 269 patients who had an in-hospital PE diagnosed using CTPA after an elective primary or revision THA or TKA performed at our institution between 2005 and 2012 were included in this institutional board review–approved study. The study group was determined by a retrospective review of the hospital's medical records and the results of the hospital's CTPAs performed during the study period. Medical records were reviewed to capture preoperative clinical and demographic data that included gender, age, BMI, diagnosis, presence of cardiopulmonary comorbidities, predisposing factors for VTE [9,12], and ASA class [13].

There were 92 men and 177 women. The average (SD) age was 69 years (10.7 years; range, 34-90 years). The average (SD) BMI was 32 kg/m^2 (7 kg/m^2; range, 20-56 kg/m^2). There were 6 ASA class 1 patients, 180 class 2, 82 class 3, and 1 class 4. Two hundred eight patients (77%) did not have a recognized predisposing factor for VTE. The remaining 61 patients (23%) who developed a PE had at least 1 predisposing factor for VTE (55 patients had only 1 predisposing factor and 6 had 2 predisposing factors).

The captured in-hospital information included the following: affected joint (hip/knee), procedure type (primary/revision), laterality, bilaterality, type of anesthesia, and postoperative chemoprophylaxis. We recorded the timing of in-hospital PE and the international normalized ratio (INR) at the moment of the diagnosis if on warfarin. Pertinent to the PE, we recorded treatment, initial PACU stay, need to transfer to a higher level of care due to hemodynamic instability (either return to PACU which in our institution functions as an intermediate care unit or transfer to intensive care unit), and total hospitalization time.

Two hundred fifty-nine patients (96%) received a regional anesthetic and 10 (4%) a general anesthetic due to a contraindication to regional anesthesia. Seventy-two patients (27%) underwent THA and the remaining 197 (73%) TKA. Fifty-eight patients underwent unilateral THA, 8 bilateral THA, 147 a unilateral TKA, 44 a bilateral TKA, 6 a revision THA, and 6 a revision TKA. Among 257 patients who underwent primary surgery, the diagnosis was osteoarthritis in 237, rheumatoid arthritis in 7, *avascular necrosis* in 6, psoriatic arthritis in 3, posttraumatic arthritis in 2, septic arthritis in 1, and spondyloepiphyseal dysplasia in 1. Among 12 patients who underwent revision surgery (6 hips–6 knees), 7 were for aseptic loosening (3 hips and 4 knees), 3 for periprosthetic osteolysis (2 hips–1 knee), 1 for recurrent dislocation (1 hip), and 1 for a deep infection (1 knee).

All patients received multimodal thromboprophylaxis [9], including preoperative discontinuation of procoagulant medication and VTE risk stratification, intention to use regional anesthesia, prompt postoperative mobilization, pneumatic compression devices [14,15], and chemoprophylaxis tailored to the individual patient's risk [6–9,12,16]. Postoperative chemoprophylaxis included aspirin in 42 patients, warfarin (goal INR = 2) in 180, warfarin with a bridge of low-molecular-weight heparin until INR was in range in 13, low-molecular-weight heparin in 3, and aspirin and warfarin in 28, and 2 patients received a preoperative inferior vena cava filter (IVCF) and postoperative warfarin. One patient with platelet dysfunction and bleeding diathesis received no postoperative chemoprophylaxis.

The average (SD) time between surgery and the diagnosis of a PE was 3 days (1.5 days; range, 1-12 days; Fig. 1). Among 210 patients who were anticoagulated with warfarin but did not receive a bridge with low-molecular-weight heparin, the INR at the time of the diagnosis was, on average (SD), 1.56 (0.47; range, 0.95-3.73; Fig. 2). There were 28 patients with an INR ≥2 (13%) and 182 with an INR <2 (87%).

All patients were followed up for a year. During that period, we recorded readmission, major bleeding, and other relevant complications requiring medical attention. If death occurred, we recorded timing and autopsy results when available.

The radiologic severity was determined by the location of the most proximal thrombus in the pulmonary circulation [17]. Three attending radiologists with experience in the evaluation of CTPA, re-reviewed all CTPAs to confirm the diagnosis and map the emboli within the pulmonary circulation. Emboli were classified as central (involving either the pulmonary trunk, left or right pulmonary artery, or one of the lobar pulmonary arteries), segmental, or subsegmental.

Statistical Analysis

Patient demographic, preoperative clinical data, predisposing factors for thromboembolic disease, ASA class, in-hospital information, and radiologic severity of the PE were summarized by using means and SDs for continuous variables and frequencies and percentages for categorical variables. *t* Tests were used to compare the difference between group means, and χ^2 tests or Fisher exact tests were used to compare the proportions between the 3 PE location categories (central, segmental, and subsegmental). Subsequently, multinomial logistic regression was used to evaluate risk factors associated with radiologic severity of the PE. Covariates were initially considered for inclusion based on clinical experience and review of the surgical literature. Any variable having a significant Wald test at $P = .2$ from logistic regression in the univariate analysis was selected as a candidate for the multivariate analysis. Covariates were removed if they were nonsignificant at the .1 α level and not a confounder. Using these a priori criteria and an iterative process of deleting and refitting, medical history of congestive heart failure (CHF), arrhythmia, and type of surgery (hip vs knee) were included in the final multivariate multinomial logistic regression model.

All analyses were conducted using SAS for Windows 9.2 (SAS Institute Inc, Cary NC). All tests were 2 sided, and a critical *P* value of .05 was set for all comparisons.

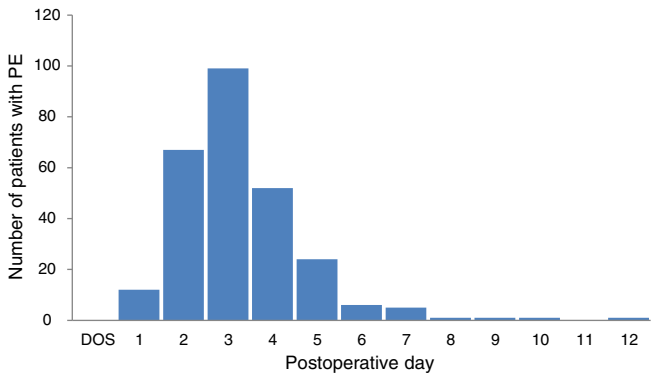

Fig. 1. Timing of in-hospital PE.