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Coagulation Laboratory Testing Is Predictive of Wound Complications Following Microdiscectomy

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Abstract

Study Design: Retrospective review.

Objective: To determine whether abnormal preoperative testing is associated with postoperative complications in patients undergoing a microdiscectomy.

Methods: Patients undergoing a microdiscectomy between 2006 and 2013 were identified in the National Surgical Quality Improvement Program database based on appropriate current procedural terminology coding. Thirty-day postoperative complications were analyzed in addition to patient demographics, comorbidities, and abnormal preoperative laboratory values. A series of over 650 univariate analyses to determine which independent variables to include for each complication were completed. Based on those analyses, 12 logistic regression models were built, one for each specific complication. Each model adjusted for age, gender, comorbidities, American Society of Anesthesiologists classification, as well as operative time.

Results: A total of 5947 patients undergoing a microdiscectomy were included in the study. Abnormal preoperative international normalized ratio (odds ratio [OR] = 5.85, $P < .05$) was associated with any wound infection, superficial or deep, and abnormal partial thromboplastin time was significantly associated with wound dehiscence (OR = 6.80, $P < .05$). Postoperative urinary tract infections were associated with abnormal preoperative hematocrit (OR = 8.00, $P < .05$). None of the identified preoperative labs were independently associated with pulmonary embolism, organ space surgical site infections, or intubation.

Conclusions: Abnormal preoperative coagulation labs were significantly associated with postoperative wound complications. However, the majority of tests were not associated with adverse events following microdiscectomy. Further study is necessary to conclude whether these tests provide information that can modify perioperative management and whether widespread testing is cost-effective.

Keywords

preoperative labs, microdiscectomy, elective surgery, outcomes, complications

Introduction

Clinical laboratory testing is a major contributor to health care spending. Medicare spent $6.7 billion on laboratory tests in 2006, and the total global market is estimated to be as large as nearly $200 billion with the United States responsible for the highest single portion of the market.[1,2] A relevant segment of clinical laboratory testing that is well positioned for optimization is preoperative tests, which account for approximately $18 billion annually in the United States.[3,4] Preoperative clinical laboratory testing has a highly variable practice pattern with unclear utility.

The American Society of Anesthesiologists (ASA) developed a practice advisory with regard to preoperative evaluation.[5] The task force concluded that routine preoperative testing should not be performed; however, the guidelines for

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specific testing are vague. The ASA guidelines state that preoperative testing should be based on patient details obtained from the history, physical exam, and patient chart, as well as on the invasiveness of the procedure. Unfortunately, the task force concluded that there is insufficient evidence in order to provide explicit indications with regard to either patient- or procedure-specific factors.

Microdiscectomies are a group of procedures with typically minimal morbidity. These procedures may be well suited for optimization with regard to preoperative testing. Currently, there is a paucity of evidence regarding whether preoperative testing correlates with postoperative complications. The goal of this research is to determine whether preoperative lab values correlate with postoperative complications in patients undergoing a microdiscectomy.

Materials and Methods

Data Collection

The American College of Surgeons National Surgical Quality Improvement Program (ACS-NSQIP) database was used to isolate 361 402 orthopedic surgery procedures performed between 2006 and 2013. Current Procedural Terminology (CPT) code 63 030 (laminotomy, hemilaminectomy for decompression of nerve root(s), including partial facetectomy, foraminotomy, and/or excision of herniated intervertebral disc; one interspace, lumbar) was subsequently employed to identify all patients undergoing discectomy, as per prior studies in the literature. Exclusion criteria included emergent procedures, any evidence of fusion, or surgery encompassing additional levels, as indicated by additional CPT coding.

Demographics, perioperative comorbidities, and intraoperative variables were identified for each patient. Demographics included age, sex, body mass index (BMI), and race. Preoperative comorbidities, including rapid weight loss, diabetes, cigarette use, prior transfusion, alcohol consumption, steroid use, congestive heart failure, dyspnea, functional dependency, myocardial infarction, peripheral vascular disease, transient ischemic attack, dialysis, bleeding disorder, prior chemotherapy/radiation treatment, sepsis, chronic obstructive pulmonary disease (COPD), hypertension, ASA score, ventilator use, cerebrovascular accident, and disseminated cancer were recorded for each patient. The total operative time was collected for all cases.

Preoperative laboratory data encompassing 13 individual tests was then recorded and dichotomized into normal or abnormal. These labs included sodium (normal = 135-145 mEq/L), blood urea nitrogen (normal = 7-20 mg/dL), creatinine (normal = 0.5-1.2 mg/dL), albumin (3.4-5.4 g/dL), bilirubin (normal = 0.3-1.9 mg/dL), serum glutamic oxaloacetic transaminase (10-34 IU/L), alkaline phosphatase (44-147 IU/L), white blood cell count (4500-10 000/μL), hematocrit (38% to 54%), platelet count (150 000-400 000/μL), prothrombin time (PT; 11-13.5 seconds), international normalized ratio (INR; 0.8-1.1), and partial thromboplastin time (PTT; 25-35 seconds). Patients in this series were determined to have normal or abnormal results based on values at our institution.

Outcome variables of interest were postoperative complications, which were assessed as 3 cumulative groups: major complications, minor adverse events, and total complications. Major complications consisted of postoperative deep wound infection, organ space infection, myocardial infarction, deep vein thrombosis, pulmonary embolism, sepsis, septic shock, cerebrovascular accident, peripheral nerve injury, coma, and death. Minor complications included superficial wound infection, pneumonia, urinary tract infection, and wound dehiscence.

Institutional review board approval was not required for this study due to the de-identified nature of the ACS-NSQIP database.

Statistical Analysis

Patient demographics, preoperative comorbidities, perioperative factors, and laboratory values were tested for association with postoperative complications via univariate logistic regression. Variables that resulted in $P < .35$ via bivariate analysis were incorporated into a binary logistic regression model, with the complication of interest as the dependent variable. A negative binomial regression model was used to analyze the determinants of total length of hospital stay. Concern for biased estimates and separation issues in the logistic regressions due to low rate of complications was mitigated by employing a penalized likelihood based method (Firth logistic regression), as suggested by multiple prior studies.[6-9] Patients with incomplete data for any variable were removed via listwise deletion.

The predictive capacity of each model was subsequently evaluated using the c-statistic (area under the receiver operating characteristic curve). Fit to the data was assessed with likelihood ratio test with a Poisson model as the comparator of the negative binomial regression, and an empty model for the logistic regressions. All comparative tests were 2-tailed, and statistical significance was established at $P < .05$. All statistical analyses were performed using STATA 14 (StataCorp, College Station, TX).

Results

A total of 5947 patients undergoing a microdiscectomy were identified in the NSQIP database. The population had 45% females, the mean age was 35 years, and 81% of the patients were white. At least one comorbidity was present in 35% of patients (Table 1). Mean BMI was 29.41, and 42% of patients had a BMI >30. Cigarette smokers accounted for 22% of the population, and 11% had diabetes. The most common ASA class was 2 (61%), followed by ASA class 3 (26%) and class 1 (12%). At least one abnormal preoperative laboratory value was found in 28.42% of patients (Table 2). The overall complication rate was quite low at 2.7% (Table 3).

Thirteen multivariate logistic regression models and one negative binomial regression model were created using results

Table 1. Demographics, Comorbidities, and Perioperative Details Including American Society of Anesthesiologists Classification.

Demographics	
Age	35.4 (15.9)
Female	45.10%
Race/ethnicity	
White	81.30%
Black	5.67%
Other	13.03%
Preoperative health and comorbidities	
BMI	29.64 (7.10)
Smoking	22.43%
Diabetes mellitus	11.45%
Steroids	2.86%
Chronic obstructive pulmonary disease	2.24%
Alcohol	2.16%
Open wound or wound infection	1.11%
History of transient ischemia attack	1.08%
History of myocardial infarction	0.11%
Chronic heart failure	0.03%
Bleeding disorder	0.89%
Other recent operation	0.62%
Peripheral vascular disease	0.23%
Recent weight loss	0.13%
Dialysis	0.13%
Chemotherapy	0.06%
Preoperative blood transfusion	0.02%
Operative variables	
Length of operation, minutes (SD)	220.17 (113.13)
Wound class	99.33%
Clean	0.40%
Clean-contaminated	0.17%
Contaminated	0.10%
Dirty or infected	
ASA class	12.07%
1: No disturbance	60.92%
2: Mild disturbance	26.06%
3: Severe disturbance	0.89%
4: Life threatening disturbance	0.05%
5: None assigned	

Abbreviations: BMI, body mass index; ASA, American Society of Anesthesiologists.

Table 2. Percentage of Abnormal Preoperative Laboratory Values in Patients Undergoing Microdiscectomy.

WBC	17.25%
PTT	14.83%
Creatinine	6.38%
Platelets	5.96%
Albumin	3.26%
INR	2.01%
Hematocrit	1.43%

Abbreviations: WBC, white blood count; PTT, partial thromboplastin time; INR, international normalized ratio.

Table 3. Percentage of Patients That Experienced Postoperative Complications.

Superficial wound infection	0.59%
Deep wound infection	0.40%
Organ space infection	0.13%
Wound dehiscence	0.18%
Any wound infection	1.21%
Unplanned reintubation	0.20%
Deep venous thrombosis	0.29%
Pulmonary embolus	0.27%
Renal insufficiency	0.02%
Urinary tract infection	0.76%
Stroke	0.05%
Sepsis	0.25%
Reoperation	1.92%

of over 650 univariate analyses to determine which independent variables to include for each complication (Table 4). Each model adjusted for age, gender, comorbidities, ASA grade, as well as operative time. Explanatory variables exhibiting complete separation for each complication were excluded. Superficial wound infections were not associated with any lab abnormalities. Preoperative lab values were not associated with deep wound infections. Any wound infection, superficial or deep, was associated with an abnormal INR (odds ratio [OR] = 5.85, $P < .05$) and COPD (OR = 4.87, $P < .05$).

Abnormal PTT was associated with wound dehiscence (OR = 6.80, $P < .05$) and COPD (OR = 23.65, $P < .05$). Postoperative urinary tract infections were associated with abnormal hematocrit (OR = 8.00, $P < .01$) and transient ischemic attack (OR = 26.59, $P < .05$). No preoperative labs were identified that were independently associated with pulmonary embolism, organ space surgical site infections, or intubation. Deep venous thrombosis, stroke, postoperative sepsis, revision surgery, or length of stay were not associated with preoperative labs. Post estimation comparison of Firth logistic regression with the standard logistic regression showed that the penalized likelihood method reduced bias away from 0. Although rare event modelling in medicine is still an active area of research, the potential bias weakens the association of the preoperative labs with the studied complications and further supports the claim of the precarious value of these tests.

Discussion

There is significant variability in practice patterns with regard to preoperative laboratory testing for patients undergoing elective procedures. Common laboratory tests ordered prior to surgery include a complete blood count (white blood cell count, platelet count, hemoglobin, and hematocrit), a PT/INR, PTT, and a basic metabolic panel, which includes a number of electrolytes in addition to creatinine. Data from this study suggests that some of the labs are associated with postoperative complications. INR is associated with wound infections when the dependent variable is set to the occurrence of a superficial or deep wound infection. PTT is associated with wound dehiscence.

Hematocrit appears to be associated with postoperative urinary tract infections. This data suggests that the full battery

Table 4. Penalized Likelihood Ratios From a Series of Firth Multivariate Logistic Regression Models[a].

	Any Wound Infection	Superficial Surgical Site Infection	Deep Surgical Site Infection	Organ-Space Occupying Infection	Wound Dehiscence	Unplanned Reintubation	Pulmonary Embolus	Deep Venous Thrombosis	Urinary Tract Infection	Stroke	Postoperative Sepsis	Reoperation
INR	5.850**	9.639*	5.978*	—	—	—	3.250	—	3.637	—	—	—
PTT	1.885	0.337	2.775*	—	6.802**	—	—	—	2.286	—	3.365*	—
HCT	1.389	—	—	4.515	—	1.034	—	—	8.000**	3.21	1.511	1.208
Albumin	0.947	2.035	—	—	—	1.536	5.073	—	—	6.032	—	—
WBC	1.716	—	0.743	3.332	0.967	4.213	—	—	—	—	—	—
Platelet count	—	—	—	—	—	—	—	—	—	—	3.351	—
Creatinine	—	—	—	—	—	—	4.428	1.454	1.763	—	—	—
N	1053	1059	2395	4582	2594	1816	250	1241	536	1823	2393	925

Abbreviations: INR, international normalized ratio, PTT, partial thromboplastin time; HCT, hematocrit; WBC, white blood cell count.
[a]Independent covariables in the model include age, gender, race, obesity, diabetes, chronic obstructive pulmonary disease, cigarette use, corticosteroid use, unexplained weight loss, and history of transient ischemic attack.
*P < .05. **P < .01. ***P < .001.

of tests including a complete blood count, basic metabolic panel, PT/INR, and PTT are rarely indicated. While PT/INR, PTT, and hematocrit are associated with some complications, it is impossible to know whether these labs lead to changes in management that lead to a lower complication rate.

Postoperative wound complications after spine surgery are a relatively common adverse event that leads to increased length of hospitalizations and increased cost of care.[10-13] Wound complications are responsible for 39% of readmissions after spine surgery, and account for an estimated $1.6 billion in annual health care expenditures.[14,15] The rate for surgical site infections ranged from 0.7% to 12% depending on the cited study.[16-20] The literature on preoperative laboratory testing as predictors of postoperative wound complications in spine surgery is poor. Lieber et al found that preoperative hematocrit below 35 was associated wound complications.[19] Outside of spine surgery, INR has been found to be associated with surgical site infections in total knee arthroplasty.[21]

Optimization of preoperative laboratory testing has been an active topic of discussion for over 30 years. In 1985, Kaplan et al examined the usefulness of routine preoperative testing in 2000 patients undergoing elective surgery.[22] They found that 60% of the tests would not be performed if only targeted testing was done, and only 0.22% of tests revealed an abnormality that would influence perioperative management. Chung et al randomized patients undergoing ambulatory surgery to standard testing versus no testing and found no difference in perioperative complications between the 2 cohorts.[23] Other trials have echoed to lack of utility of routine preoperative testing.[24-28]

Despite this evidence, providers continue to order a significant number of preoperative tests. Brown et al[29] surveyed 23 physicians and nurse administrators for reasons why they order preoperative tests. The authors concluded that there are 5 reasons why these practice patterns continue: (1) practice tradition, (2) belief that another physician wants tests, (3) medical-legal concerns, (4) concern about surgical delays or cancellation, and (5) lack of awareness of evidence or guidelines. The presented data suggests that a large portion of standard laboratory tests do not correlate with postoperative complications. Three of the laboratory tests correlate with postoperative complications.

This data should be assessed in the context of limitations in study design. First, although NSQIP data is collected prospectively, this represents a retrospective review and is thus subject to selection bias. This was partially mitigated by including a large series of patients from diverse sites around the country. Second, complications are only recorded within 30 days of surgery, and as such the true rate of adverse events may be underestimated. In addition, abnormal preoperative labs could not be examined in regard to long-term outcomes. The use of a national registry, while advantageous in terms of sample size, precluded the incorporation of certain variables that are specific to spine surgery, but are not collected as part of the database. Specifically, motor and neurological exams along with patient-reported outcomes could not be assessed. Finally, the included data provides suggestions regarding the association between abnormal laboratory values and postoperative complications, or lack thereof, but it is unclear whether these relationships represent modifiable factors that lend themselves to preoperative optimization.

In conclusion, abnormal preoperative coagulation labs (PTT, INR) were significantly associated with a variety of postoperative wound complications. However, the majority of tests were not associated with adverse events following microdiscectomy.

Declaration of Conflicting Interests

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