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Quantifying and Predicting Surgeon Work Input in Primary vs Revision Total Hip Arthroplasty

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ABSTRACT

Background: Primary total hip arthroplasties (THAs) performed annually are projected to increase 174% by 2030, causing a parallel increase for revision THA. Increased surgical effort and readmission rates associated with revision THA may discourage surgeons from performing them. Although revision THA Medicare reimbursement is greater, it may be disproportionate to time and effort. We examined work input between primary and revision THA, assessing predictive factors. We also compared surgeon work input to current reimbursement.
Methods: A total of 156 patients were identified, 80 primary and 76 revision THA. Demographic, clinical, and radiographic data were collected. Radiographic data were collected from the most recent preoperative radiographs taken before primary or revision THA. Multiple linear and logistic regression models were used to identify patient factors contributing to select outcome variables by a stepwise method, with a probability value for entry ($P = .05$) and removal ($P = .10$). Residual analysis was performed, confirming validity of these models.
Results: Average age, body mass index, and percentage of female patients were similar between cohorts. There was no statistically significant difference between the demographic variables, although data revealed patient variables contributing to statistically significant increases in surgical time, length of stay, blood loss, and complications with revision THA.
Conclusion: Despite a 66% increase in "percent effort" and 3-fold higher readmission rate, revision THA requires at least a 2-fold increase because of nonquantifiable factors. Revision THA demonstrates a substantial increase in work effort not commensurate with current Medicare reimbursement, which may force surgeons to limit or eliminate revision arthroplasties performed reducing access to patient care.

The demand for total hip arthroplasty (THA) is increasing as the United States population ages. By the year 2030, the number of THAs performed annually is projected to increase 174% [1]. With this increased demand for primary THA will come a parallel increase in demand for revision THA. Orthopedic surgeons recognize the increased surgical effort associated with revision hip surgery, and this may influence the number of surgeons who are electively willing to perform these operations. The increased time spent not only in the operating room but also the outpatient setting and hospital floor will further influence those agreeable to take on revision cases. In addition, unplanned readmission rates for revision THA are nearly double those of primary THA at 90 days [2]. Although Medicare surgeon reimbursement is greater for revision THA, the increased fees may not be proportional to the increased time and effort required for revision surgery [3]. Total joint replacement volume has increased 26% from 2000 to 2011, yet the net physician reimbursement has decreased 2.5% for all primary and revision surgeries combined [1,4].

Our goal was to examine surgeon work input between primary and revision THAs and assess predictive factors of greater work

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input. The ability to predict difficult cases allows for improved preoperative planning, better operating room time allocation, better postoperative care, and improved understanding of resource utilization. Therefore, we hoped to elucidate what, if any, demographic, clinical, and radiographic patient variables may be predictive of increased surgeon work input. In addition, we sought to compare surgeon work input associated with revision hip arthroplasty as it relates to current reimbursement.

Methods

With the approval of our institutional review board, we used our institutional database to identify primary and revision THA patients operated on by one of 4 high-volume arthroplasty surgeons at a single tertiary care hospital. All surgeries were performed between January 2013 and December 2014. A total of 156 patients were identified from office records using the current procedural terminology codes for primary THA (27130) and revision THA (27134, 27137, and 27138). For each case, electronic hospital and office medical records were used to collect demographic, clinical, and radiographic data. Inclusion criteria included (1) skeletally mature, (2) underwent primary or revision THA by a participating surgeon at our tertiary care hospital, (3) surgery performed within the 2-year time frame. A total of 80 primary (20/surgeon) and 76 revision THA patients were identified over the course of this study and included for data collection.

Revision procedures were only included if a minimum of 3 out of 4 hip components (cup, liner, head, or stem) were revised. Revisions solely involving exchange of modular components were not included. Outlier patients, defined as the best or worst 20% in regard to length of surgery, length of stay (LOS), and blood loss, were further evaluated. Potential contributing patient variables (body mass index [BMI], >40; prior surgery with retained hardware; extended trochanteric osteotomy performed; postoperative anemia requiring transfusion; postoperative intensive care unit stay) for the outlier patients were recorded.

Demographic data included age, sex, and BMI (Table 1). Clinical data included preoperative diagnosis necessitating primary THA, preoperative diagnosis necessitating revision THA, number of components revised, prior surgeries, type of prior hip surgery, the American Society of Anesthesiologists physical function score (ASA), and presence of retained nonarthroplasty hardware. Demographic and clinical data were obtained from electronic medical records including physicals, surgical operative notes, and anesthesia records. All personal health information was recorded and secured on password-encrypted Excel data storing software.

Radiographic data were collected from the most recent preoperative office radiographs taken before primary or revision THA. Radiographic data included presence of acetabular protrusion (defined as medial migration beyond Kohler's line), degree of heterotopic ossification (HO; Brooker classification), cemented/cementless stem, modular vs nonmodular stem, primary vs revision stem (defined as stem length >130 mm), lysis of the femur (Gruen zones), lysis of the acetabulum (Delee and Charnley zones), femoral bone loss (Paprosky classification: 0-4), acetabular bone loss (Paprosky classification: 1-3), presence and number of cerclage wires, presence and number of acetabular cup screws, and presence of cement distal to the tip of the femoral stem.

Length of surgery was defined as time from skin incision to skin closure and obtained from anesthesia records. Mean blood loss was calculated through the sum of blood collected in suction canisters and number of saturated surgical laps/sponges. If the anesthesia and surgical operative notes differed in volume of blood loss, the higher number was recorded. LOS was defined as the number of nights from admission to discharge. We defined "percent effort" to quantify any increased effort associated with revision THA. This was calculated using each individual surgical time/the average primary THA surgical time. Finally, complications were evaluated within 90 days of surgery. Complications were classified into one of 4 categories: readmission within 30 days for any reason, postoperative infection requiring surgical intervention or readmission, nerve palsy and/or postoperative instability. Minor occurrences, such as postoperative anemia, pyrexia, and urinary tract infection, were not included as a complication.

Table 1
Patient Demographics.

Patient Data	Primary THA	Revision THA	*P* Value
Number of patients	92	76	n/a
Age (y)	66.07	67.79	.36
BMI	30.3	29.9	.67
Gender (female)	48 (52.2%)	37 (48.7%)	n/a

THA, total hip arthroplasty; BMI, body mass index; n/a, not applicable.

Statistical Analysis

Statistical analyses were performed to determine if any correlation existed between patient demographic, clinical, and radiographic data and surgeon work input, as measured by length of surgery, LOS, surgical blood loss, and percent of effort. A Student t test with a level of statistical significance set to $P < .05$ was used to compare outcome variables between primary and revision THAs. In addition, the student t test was used to compare outlier patients (best 20% vs worst 20%) for each outcome variable. Multiple linear and logistic regression models were used to identify patient factors that contributed to the select outcome variables by a stepwise method, with a probability value for entry ($P = .05$) and removal ($P = .10$). Residual analysis was performed, confirming the validity of these models. All statistical analyses were performed using IBM SPSS Statistics, version 23, for Windows.

Results

The average age, BMI, and percentage of female patients were similar between primary and revision cohorts (Table 1). There was no statistically significant difference between any of the demographic variables, and thus, our results should not be influenced by demographic discrepancies between the primary or revision THA cohorts.

Work Input "Percent Effort"

The mean length of surgery for primary THA was 76 minutes (standard deviation [SD]: 25, range: 41-159 minutes). The mean length of surgery for revision THA was 124 minutes (SD: 40, range: 53-263 minutes). The difference of 48 minutes was statistically significant ($P < .0001$; Fig. 1 and Table 2). The mean LOS for primary THA was 2.7 (SD: 4.8, range: 1-48 days). The mean LOS for revision THA was 4.7 (SD: 3.8, range: 1-21 days). The difference of 2 days was statistically significant ($P < .0031$; Table 3). The mean blood loss for primary THA was 225 mL (SD: 150, range: 50-1300 mL). The mean blood loss for revision THA was 510 mL (SD: 356, range: 100-2100 mL). The difference of 285 mL was statistically significant ($P < .0001$; Fig. 2 and Table 4). The percent of effort for surgery was determined to be 1.66-fold or 66% increased effort for revision, compared to primary THA. Each individual revision THA length of surgery was divided by the average primary THA length of surgery. We then averaged all of these to get 1.66.