The “July effect” in total shoulder arthroplasty

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Background: New medical doctors enter their residency fields in July, a time in the hospital in which patient morbidity and mortality rates are perceived to be higher. It remains controversial whether a “July effect” exists in different areas of medicine and surgery, including in orthopedic surgery. The purpose of this study is to test for the July effect in patients undergoing primary total shoulder arthroplasty (TSA).

Methods: Patients who underwent primary TSA from 2005-2012 were identified using the American College of Surgeons National Surgical Quality Improvement Program database. Cases were categorized as involving residents or fellows and as occurring during the first academic quarter. Rates of composite and any adverse event outcomes were compared between patient groups using multivariate logistic regression.

Results: A total of 1591 patients met the inclusion criteria. Of these cases, 711 (44.7%) had resident or fellow involvement and 390 (24.5%) were performed in the first academic quarter. There were few demographic and comorbidity differences between cases with and without residents or fellows or between cases performed during the first quarter and during the rest of the year. Overall, the rate of serious adverse events was 1.6% and the rate of any adverse events was 6.5%.

Discussion and conclusion: Using one of the largest cohorts of primary TSA patients, this study could not provide evidence for a July effect. In the context of the recent growth in the volume of TSA procedures, these findings provide important reassurance to patients that it is safe to schedule their elective procedures at training institutions during the first part of the academic year.

Level of evidence: Epidemiology Study; Large Database Analysis

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students participating in surgery may result in a public perception of higher risks and may lead patients to avoid elective surgery during the month of July. In the surgical literature, studies have been performed refuting the July effect, relating patient level of disease burden as a risk factor during that time. However, some studies still report on this seasonal variation. Recently, Anderson et al used the National Inpatient Sample to look at overall mortality rates of elderly patients hospitalized for a femoral neck or intertrochanteric hip fracture in teaching versus nonteaching hospitals. The overall mortality rate was slightly higher in teaching hospitals (3.69% vs 3.61%, not statistically significant); however, when assessing the adjusted relative risk (RR) in July and August, the authors reported a 12% greater RR of mortality in teaching hospitals during these months, suggesting a July effect. Similarly, Nandyala et al reported on perioperative outcomes after anterior cervical spine fusion using the National Inpatient Sample. They reported that during July, patients treated in teaching hospitals incurred higher rates of superficial infections, longer hospital stays, and more complications such as deep venous thrombosis. Gruskay et al also found a significantly higher incidence of wound infection after spinal surgery during the beginning of the academic year.

Other authors, however, have refuted the existence of the July effect with notable studies involving closed reduction and percutaneous pinning of supracondylar humeral fractures, elective spine surgery, primary joint replacement, and adolescent idiopathic scoliosis surgery. Overall, the implications of the July effect can have a significant impact for patients, resident trainees, attending physicians, and hospital systems. With a perceived difference in patient outcomes, such a myth could greatly affect elective orthopedic procedures, deterring patients from undergoing surgery during the early months of the academic year.

The purpose of this study is to test for the July effect in patients undergoing elective primary total shoulder arthroplasty (TSA). We hypothesized that the data would not identify the perceived July effect in patients undergoing elective primary TSA.

Methods

This study used the American College of Surgeons National Surgical Quality Improvement Program (ACS NSQIP) database, a prospective, multi-institutional national database of outcomes. It is an established database that collects outcome-based measures on surgical patients from over 350 hospitals. The collected data are based on medical records rather than insurance records, and include data for patients undergoing both inpatient and outpatient surgery, specifically indicating preoperative comorbidities, intraoperative variables, and postoperative morbidity and mortality outcomes within 30 days.

Patients who underwent primary TSA (reverse or anatomic) during 2005-2012 were identified using the ACS NSQIP improvement program. Cases were categorized based on resident or fellow involvement, as well as whether they occurred during July, August, or September (first academic quarter) versus October through June. By use of ACS NSQIP criteria, each patient was characterized in terms of age (18-59 years, 60-69 years, 70-79 years, ≥80 years); sex; functional status (dependent vs independent); current smoking status; American Society of Anesthesiologists score (1 or 2 vs 3 or 4); and the presence of anemia, chronic obstructive pulmonary disease, dyspnea on exertion, and hypertension.

In addition, we examined 2 composites of adverse events, designated “serious adverse events” (SAEs) and “any adverse events” (AAEs), as well as 23 individual adverse event outcomes. SAEs were defined as previously described and included the following: acute intubation, acute renal failure, cardiac event (including cardiac arrest or myocardial infarction), cerebrovascular event (including stroke), coma for more than 24 hours, pulmonary embolism, sepsis, unanticipated return to the operating room, ventilator dependence for more than 48 hours, and death. AAEs were also defined as previously described and included the following: any of the SAEs previously listed, deep vein thrombosis (including thrombophlebitis), failure of any graft or prosthesis used, injury to the peripheral nerve, infection (including superficial, deep surgical site, deep space, urinary tract, respiratory, or organ), renal insufficiency, transfusion of greater than 5 U, or wound dehiscence.

Statistical analyses were conducted in Stata (version 13.1; StataCorp, College Station, TX, USA). We first conducted comparisons of patient characteristics between groups. A Student’s t test was used for analyses of continuous variables, and a Pearson χ² test was used for analyses of categorical variables. Patient characteristics were compared between (1) cases with and without resident involvement and (2) cases occurring during the first academic quarter and during the rest of the year.

Rates of SAEs and AAEs were compared between patient groups using multivariate Poisson regression with robust error variance between (1) cases with and without resident involvement and (2) cases occurring from July through September and occurring from October through June. Multivariate Poisson regression was used so that outcomes could be reported as RRs. These comparisons all included controls for the demographic characteristics and comorbidities noted earlier.

The presence of the July effect was evaluated for using an interaction term. Specifically, multivariate models were constructed with SAEs and AAEs as the outcomes with predictor variables including resident or fellow involvement, academic season, an interaction term between resident or fellow involvement and academic season, and each of the baseline patient characteristics noted earlier. Statistical significance of the interaction term in these models would indicate an interaction between resident involvement and academic quarter. This would represent a change that is specific to having residents present during the first quarter of the academic year—a change that is over and above any baseline change between cases with and without resident involvement or seasonal variation. This process was repeated for each of the individual adverse events. As a final step, operative times were compared between groups using multivariate linear regression with controls for all baseline characteristics, as well as interaction terms, in a manner parallel to that noted earlier.

Results

A total of 1591 patients met the inclusion criteria. Of these cases, 711 (44.7%) had resident or fellow involvement and 390 (24.5%) were performed in the first academic quarter.
There were few demographic and comorbidity differences between cases with and without residents or fellows (Table I). Similarly, there were few demographic and comorbidity differences between cases performed during the first 3 months of the academic year and cases performed during the rest of the year (Table II).

After adjustment for demographic characteristics and comorbidities, resident involvement in cases had no impact on the rate of SAEs (1.28% vs 1.67%; RR, 0.77; 95% confidence interval [CI], 0.35-1.70; \( P = .520 \)) or the rate of AAEs (7.50% vs 5.34%; RR, 1.38; 95% CI, 0.94 to 2.01; \( P = .098 \)). Similarly, after adjustment for demographic characteristics and seasonality, there was no impact on the rate of SAEs (1.28% vs 1.67%; RR, 0.79; 95% CI, 0.29 to 2.20; \( P = .384 \)) or the rate of AAEs (7.50% vs 5.34%; RR, 0.98; 95% CI, 0.64 to 1.49; \( P = .912 \)).

Overall, the rate of SAEs was 1.6% and the rate of AAEs was 6.5%. Critically, after adjustment for demographic characteristics and comorbidities, the interaction term was not associated with SAEs (RR, 0.5; 95% CI, 0.1-3.7; \( P = .592 \)) or AAEs (RR, 0.8; 95% CI, 0.3-1.9; \( P = .586 \); Table III). Similarly, in the analyses of each of the individual adverse events, in no case was the interaction term associated with occurrence of the adverse event (\( P > .05 \) in all cases; Table III).

Cases with resident involvement had a shorter operative time than cases without resident involvement (113.2 minutes vs 121.1 minutes, \( P < .001 \)). However, there was no difference in operative time between cases occurring during the first academic quarter and cases occurring during the rest of the year (117.2 minutes vs 116.6 minutes, \( P = .882 \)). Finally, the interaction term was not associated with operative time (coefficient, 9.2; 95% CI, –1.3 to 19.7; \( P = .087 \)).

**Discussion**

The July effect is a hypothetical, perceived phenomenon that associates higher morbidity and mortality rates among patients treated in July with the addition of new residents and trainees. By using the ACS NSQIP database, one of the largest cohorts of primary TSA patients to date, this study could not provide evidence for a July effect in primary TSA.

Seasonality in elective surgical outcomes has previously focused on resident inexperience as responsible for a July effect.
Table III  Evaluation for July effect in total shoulder arthroplasty

<table>
<thead>
<tr>
<th>Composite adverse event outcomes</th>
<th>Adverse event rate, %</th>
<th>Interaction term*</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Rest of year (n = 1201)</td>
<td>First academic quarter (n = 390)</td>
</tr>
<tr>
<td></td>
<td>No residents or fellows (n = 546)</td>
<td>Residents or fellows (n = 655)</td>
</tr>
<tr>
<td>Serious adverse events</td>
<td>1.74</td>
<td>1.57</td>
</tr>
<tr>
<td>Any adverse events</td>
<td>5.17</td>
<td>7.74</td>
</tr>
<tr>
<td>Individual adverse events†</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Death</td>
<td>0.00</td>
<td>0.31</td>
</tr>
<tr>
<td>Coma</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>Failure to wean from ventilator</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>Re-intubation</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>Cerebrovascular accident</td>
<td>0.37</td>
<td>0.31</td>
</tr>
<tr>
<td>Pulmonary embolism</td>
<td>0.18</td>
<td>0.15</td>
</tr>
<tr>
<td>Cardiac arrest requiring resuscitation</td>
<td>0.18</td>
<td>0.00</td>
</tr>
<tr>
<td>Myocardial infarction</td>
<td>0.18</td>
<td>0.15</td>
</tr>
<tr>
<td>Renal insufficiency</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>Sepsis</td>
<td>0.18</td>
<td>0.15</td>
</tr>
<tr>
<td>Septic shock</td>
<td>0.00</td>
<td>0.15</td>
</tr>
<tr>
<td>Return to operating room</td>
<td>0.73</td>
<td>0.46</td>
</tr>
<tr>
<td>Dehiscence</td>
<td>0.00</td>
<td>0.15</td>
</tr>
<tr>
<td>Superficial surgical site infection</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>Deep surgical site infection</td>
<td>0.00</td>
<td>0.15</td>
</tr>
<tr>
<td>Organ/space surgical site infection</td>
<td>0.00</td>
<td>0.15</td>
</tr>
<tr>
<td>Urinary tract infection</td>
<td>0.92</td>
<td>0.92</td>
</tr>
<tr>
<td>Pneumonia</td>
<td>0.55</td>
<td>0.46</td>
</tr>
<tr>
<td>Anemia requiring transfusion</td>
<td>1.83</td>
<td>4.73</td>
</tr>
<tr>
<td>Renal failure</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>Graft, prosthesis, or flap failure</td>
<td>0.18</td>
<td>0.00</td>
</tr>
<tr>
<td>Peripheral nerve injury</td>
<td>0.18</td>
<td>0.76</td>
</tr>
<tr>
<td>Deep vein thrombosis</td>
<td>0.37</td>
<td>0.15</td>
</tr>
</tbody>
</table>

CI, confidence interval; RR, relative risk.
* Interaction term derived from multivariate regression with predictor variables that included resident involvement, first quarter of the year, an interaction term for resident involvement and first quarter of the year, and controls for demographic and comorbidity variables. Statistical significance of the interaction term would indicate an interaction between the presence of residents and the first academic quarter. This would represent a change that is specific to having residents present during the first quarter of the academic year—a change that would be over and above any baseline seasonal variation and over and above any baseline change between cases with and without resident involvement. In short, a statistically significant term would indicate the presence of a July effect.
† Statistical analysis could not be performed when there were no adverse events occurring in one or more groups in the four groups.
effect. However, this study showed no significant differences in TSAs performed from July through September compared with the remainder of the year. Gruskay et al. examined spine surgery rates of postoperative infection and did find a significant difference in summer compared with the other seasons. However, they acknowledge that many additional factors contributed to seasonal differences including elevated temperatures and humidity conducive to infection and increased trauma-related admissions in the summer months.

In addition, our study specifically found no significant difference in cases with or without resident involvement. Haughom et al. similarly reported this finding looking at total hip arthroplasty and total knee arthroplasty. They found that 30-day complication rates were not affected by resident involvement. Factors that did influence 30-day complication rates included increased age, comorbidities, history of stroke and/or cardiac surgery, obesity, and operative time. However, across all orthopedic specialties, including joint replacement, revision cases, spinal fusions, and orthopedic trauma, Pugely et al. did find that resident involvement was associated with increased minor morbidity, operative time, and length of hospital stay. They concluded that to address these concerns, future initiatives should be undertaken to improve resident surgical skills training in the academic setting.

New focus has been placed on resident work hours within surgical fields. In 2003, the Accreditation Council for Graduate Medical Education announced new restrictions, limiting the work week to less than 80 hours, limiting on-call shifts to no more than 1 in 3 nights, and mandating more than 1 day off in a 7-day cycle. However, after the duty-hour reform, no significant changes were seen in outcomes comparing teaching hospitals with nonteaching hospitals. With no differences seen in outcomes after limiting resident work hours, similar to the July effect and the perceived notion that resident inexperience contributes to poor surgical outcomes, the question became, ‘Do these restrictions need to exist?’

The goal of these limited work hours has recently come into question with the Flexibility in Duty Hour Requirements for Surgical Trainees (FIRST) trial. In this trial, 118 general surgery residency programs in 154 hospitals were randomized either to the established Accreditation Council for Graduate Medical Education work-hour restrictions or to the intervention arm. The goal of this study will be to examine prospective data to assess the effect of changes in work-hour regulations on patient outcomes as well as resident education and well-being. This could also potentially affect the perceived July effect throughout surgical specialties, showing that work-hour restrictions and restricting resident and fellow involvement in the early months may not adversely affect patient outcomes.

Limitations

There are notable limitations to this study. Notably, there are no available data on the long-term outcomes after TSA. These specific outcomes, including rates of infection, dislocation, and reoperation, as well as functional outcomes, are beyond the scope of this study, which focused on 30-day perioperative outcomes. In addition, data were not available on the resident’s level of training, ranging from postgraduate year (PGY) 1 to PGY 5. There is no available information on the level of resident or fellow involvement, and a significant difference exists between watching a surgical case and being actively involved. Because TSA is a more complex surgical procedure, there may be a selection bias looking at a procedure with limited junior resident involvement, potentially affecting the 30-day perioperative outcomes. The reported outcomes that come from this pooled database study may be below those of individually reported surgeons; however, given that this database provides only 30-day perioperative reported outcomes, it may be similar to studies focusing on this early period. Future studies looking at long-term outcomes and stratifying based on PGY would be valuable studies to further investigate the July effect.

Conclusions

Restricted work hours and the myth of the July effect can both limit trainee’s surgical experience. As the ultimate goal of training programs is to produce well-trained, experienced surgeons, disproving the association between seasonality and outcomes can lead to increased resident participation in cases and enhanced clinical training. In the context of the recent growth in the volume of TSA procedures, these findings provide important reassurance to patients that it is safe to schedule their elective shoulder replacement procedures at training institutions during the first portion of the academic year.

Disclaimer

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References