Spine
SPINE Volume 46, Number 12, pp 836–843

"July Effect" Revisited: July Surgeries at Residency Training Programs are Associated with Equivalent Long-term Clinical Outcomes Following Lumbar Spondylolisthesis Surgery

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Study Design. Retrospective analysis of a prospective registry.

Objective. We utilized the Quality Outcomes Database (QOD) registry to investigate the "July Effect" at QOD spondylolisthesis module sites with residency trainees.

Summary of Background Data. There is a paucity of investigation on the long-term outcomes following surgeries involving new trainees utilizing high-quality, prospectively collected data.

Methods. This was an analysis of 608 patients who underwent single-segment surgery for grade 1 degenerative lumbar spondylolisthesis at 12 high-enrolling sites. Surgeries were classified as occurring in July or not in July (non-July). Outcomes collected included estimated blood loss, length of stay, operative time, discharge disposition, complications, reoperation and readmission rates, and patient-reported outcomes (Oswestry Disability Index [ODI], Numeric Rating Scale [NRS] Back Pain, NRS Leg Pain, EuroQol-5D [EQ-5D] and the North American Spine Society [NASS] Satisfaction Questionnaire). Propensity score-matched analyses were utilized to compare postoperative outcomes and complication rates between the July and non-July groups.

Results. Three hundred seventy-one surgeries occurred at centers with a residency training program with 21 (5.7%) taking place in July. In propensity score-matched analyses, July surgeries were associated with longer operative times (average treatment effect = 22.4 minutes longer, 95% confidence interval 0.9–449.0, $P = 0.041$). Otherwise, July surgeries were not associated with significantly different outcomes for the remaining perioperative parameters (estimated blood loss, length of stay, discharge disposition, postoperative complications), overall reoperation rates, 3-month readmission rates, and 24-month ODI, NRS back pain, NRS leg pain, EQ-5D, and NASS satisfaction score ($P > 0.05$, all comparisons).

Conclusion. Although July surgeries were associated with longer operative times, there were no associations with other clinical outcomes compared to non-July surgeries following lumbar spondylolisthesis surgery. These findings may be due to the increased attending supervision and intraoperative education during the beginning of the academic year. There is no evidence that the influx of new trainees in July significantly affects long-term patient-centered outcomes.

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Acknowledgment date: September 1, 2020. First revision date: October 4, 2020. Acceptance date: October 28, 2020.

The manuscript submitted does not contain information about medical device(s)/drug(s).

No funds were received in support of this work.

Relevant financial activities outside the submitted work: board membership, consultancy, grants, patents, royalties, stocks, employment, travel/accommodations/meeting expenses.

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DOI: 10.1097/BRS.0000000000003903

Key words: academic neurosurgery, July effect, lumbar, patient-reported outcomes, quality outcomes database, resident education, spine surgery, spondylolisthesis.
Level of Evidence: 3
Spine 2021;46:836–843

Degenerative lumbar spondylolisthesis affects approximately 11.5% of the US population.[1–5] For symptomatic patients who fail conservative management, surgery is effective[4] and is being increasingly utilized.[6] Thus, the rates of lumbar spine surgery are growing at both teaching and non-teaching hospitals. At the former, surgical training is based on a model of graduated resident responsibility tied to level of training. Importantly, teaching centers are tasked with providing resident education without compromising patient safety.[7]

The "July Effect" refers to a hypothesized increase in morbidity and mortality at academic medical centers due to the transition in resident responsibilities that takes place at the beginning of each academic year.[8,9] There are a number of studies focused on a variety of surgical subspecialties that support an increased incidence of adverse events in the late summer. However, other studies have not observed inferior outcomes at the beginning of the new academic year. For spine surgery specifically, there are few studies examining whether a "July Effect" exists and the conclusions vary.[10–15]

Despite the importance of such study, previous investigations on this topic often utilize non–spine-specific databases, such as the Nationwide Inpatient Sample (NIS) and National Surgical Quality Improvement Program (NSQIP), and are therefore limited in assessment of relevant spine-specific outcomes.[15,16] Data from the NIS and NSQIP are limited to inpatient stays and 30-day postoperative periods, respectively. Unlike the NIS and NSQIP, the Quality Outcomes Database (QOD) is a prospectively maintained neurosurgical registry reporting validated, spine-focused patient-reported outcomes (PROs) thereby permitting a more valid evaluation of the "July Effect" on patients undergoing spine surgery.[17] Additionally, long-term PROs are tracked, thus permitting investigations using the QOD to comment on the actual effectiveness of surgical care received. Since the patient is the sole arbiter of surgical success, investigations on the "July Effect" that do not include PROs fail to capture end points relevant to patients.

Toward this aim, the present study investigates the "July Effect" as it pertains to lumbar spondylolisthesis surgery through a retrospective analysis of the multicenter, prospective QOD registry.

METHODS

Data Source

We queried the QOD registry for patients who underwent single-segment surgery for grade 1 degenerative lumbar spondylolisthesis between July 1, 2014 and June 30, 2016 at QOD spondylolisthesis module sites with residency trainees. Inclusion and exclusion criteria of the cohort have been published previously.[18–21] Preoperative radiographs, standing or dynamic, were used to determine the diagnosis of grade 1 degenerative lumbar spondylolisthesis. The QOD registry collects demographic information (age, sex, BMI, ethnicity, education level, employment), patient comorbidities (smoking, diabetes, coronary artery disease, anxiety, osteoporosis, depression, American Society of Anesthesiologists classification), and clinical characteristics (dominant presenting symptom, ambulation status, symptom duration, presence of a motor deficit).

Outcomes

Short-term and long-term outcomes were collected including estimated blood loss (EBL), hospital length of stay, operative time, discharge disposition, 30-day postoperative complications, 90-day readmission, and reoperation within 24 to 36 months. Thirty-day postoperative complications included deep vein thrombosis (DVT) or pulmonary embolism, any neurologic deficit, myocardial infarction, urinary tract infection, surgical site infection, hematoma formation, cerebrovascular accident, durotomy, and pneumonia.

PROs were assessed through validated questionnaires at 24 months using the Owestery Disability Index (ODI), the Numeric Rating Scale (NRS) Back Pain and Leg Pain scores, the EuroQol-5D, and the North American Spine Society (NASS) Satisfaction Questionnaire.[22–25] The NASS satisfaction questionnaire gauges patient satisfaction after surgery through a survey involving four answer choices scored 1 through 4, respectively: "surgery met my expectations," "I did not improve as much as I had hoped but I would undergo the same operation for the same results," "surgery helped but I would not undergo the same operation for the same results," and "I am the same or worse as compared before surgery."

Statistical Analysis

Univariate analyses utilized paired and unpaired *t* tests and Pearson χ^2. In the case of a 2×2 with a cell count of 0, the Fisher exact test was utilized. Propensity score-matched analyses were utilized (STATA package *ps2match*) to compare postoperative outcomes between July and non-July cohorts, adjusting for variables reaching $P < 0.20$ on univariate analyses. *P* values were two-tailed and an alpha of 0.05 for considered statistically significant.

RESULTS

Patient Demographics

We identified 608 patients who underwent single-segment surgery for grade 1 degenerative lumbar spondylolisthesis. Three hundred seventy-one (61.0%) of the surgeries occurred at centers with a residency training program (237 [39.0%] of surgeries occurred at centers without residency training programs). Figure 1 shows the number of cases occurring each month.

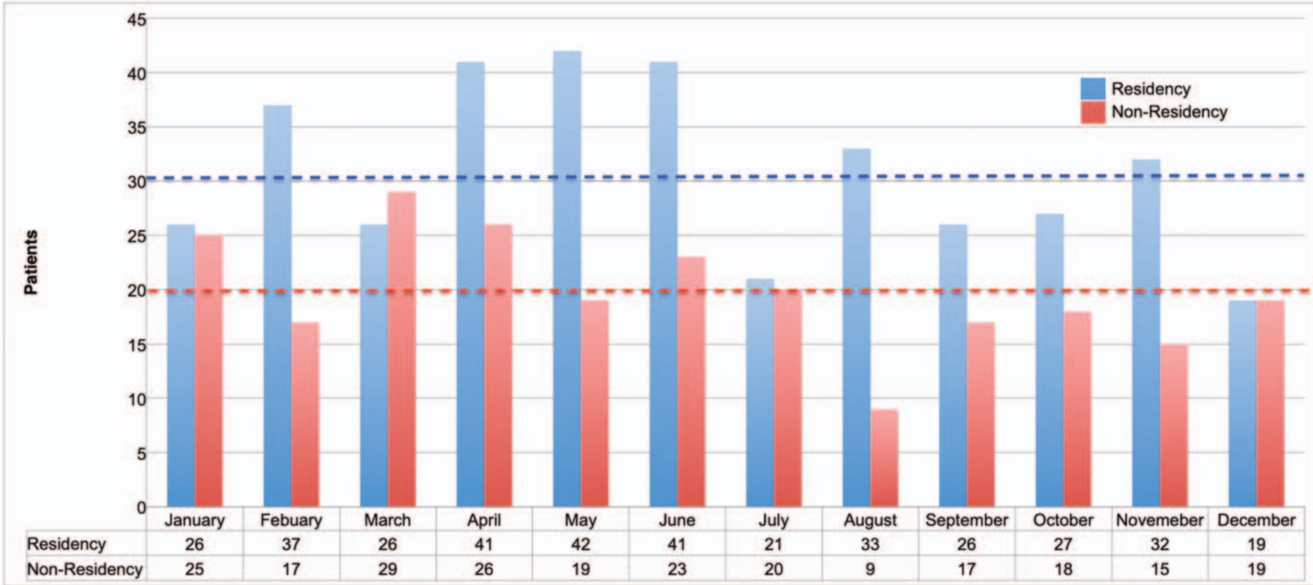

Figure 1. Distribution of surgeries, by month, at centers with a residency training program (gray) and without an associated residency training program (black). The gray and black dotted lines represent the expected number of surgeries for centers with and without residency training programs, respectively, if cases were equally distributed across months.

For residency training programs, cases were not equally distributed across months ($\chi^2 = 22.5$; df = 11; $P = 0.02$). This was driven by a higher number of procedures performed in the second quarter (April–June) (n = 124; 33.4%) and a lower number of surgeries conducted in July (n = 21; 5.7%) and December (n = 19; 5.1%). The month-to-month distribution of surgeries at centers with and without residency training programs was different ($\chi^2 = 58.3$, df = 11, $P < 0.001$). This was driven by the more equal distribution of cases across the year for centers without residents ($\chi^2 = 16.2$, df = 11, $P = 0.13$).

Of the 371 surgeries at residency training programs, 21 (5.7%) took place in July and 350 (94.3%) took place in months other than July (non-July). Descriptive characteristics are presented in Table 1. Patients undergoing surgery in July had a higher proportion of patients with ≥4 years of college level education than those undergoing surgery in other months (66.7% *vs.* 42.1%, $P = 0.027$). There were no remaining significant differences in demographic and socioeconomic characteristics, comorbidities, clinical presentation, or surgical characteristics between July and non-July surgeries.

Perioperative Parameters and Clinical Outcomes

Table 2 compares perioperative outcomes, readmission, reoperation, and complication rates and Table 3 compares PROs for non-July and July admissions. There were no significant differences on univariate analysis.

Propensity Score-Matched Analyses

A propensity score-matched analyses of outcomes between non-July and July cohorts were performed as listed in Table 4 for blood loss, operative time, length of stay and 24-month PROs. Analyses were not conducted for non-routine discharge, readmission, reoperation, and complications because there were one or fewer occurrences of each in the July cohort. July surgeries were associated with significantly longer operative times (average treatment effect = 22.4 minutes longer, 95% confidence interval 0.9–449.0, $P = 0.041$). Otherwise, EBL and length of stay did not differ significantly between the two groups. Additionally, there were no statistically significant differences in PRO measures at 24 months.

DISCUSSION

In the present study, although July surgeries were associated with longer operative times, we found no differences in the remaining perioperative outcomes, readmissions, reoperations, complications, and long-term PROs between July and non-July admissions at participating teaching institutions in a multicenter, prospective spine registry.

Our finding that July surgeries were associated with longer operative times is consistent with a previous study by Gruskay *et al*[26] that found that spine surgeries occurring during summer months at a tertiary referral center were associated with significantly longer operative times compared to the winter and spring months. However, this stands in contrast to another study by Hoashi *et al*[13] that did not find a difference for operative time in a multicenter cohort of 575 patients undergoing surgery for adolescent idiopathic scoliosis. This latter study is consistent with others finding no differences in operative time between surgeries conducted in the first and last academic quarters for adult[27] and pediatric[28] neurosurgical cases. Our finding may reflect the increased attending-to-resident intraoperative education during the beginning of the new academic year. Indeed,

TABLE 1. Characteristics of Patients Undergoing Surgery for Grade 1 Degenerative Lumbar Spondylolisthesis

	Non-July (n = 350)	SD or %	July (n = 21)	SD or %	*P*
Mean age, y	61.8	12.5	60.7	11.6	0.697
Female, n	200	57.1	9	42.9	0.200
Mean BMI	29.9	5.9	29.9	7.0	0.951
Comorbidities, n					
Diabetes mellitus	57	16.3	4	19.1	0.740
Coronary artery disease	36	10.3	4	19.1	0.209
Anxiety	57	19.1	4	19.1	0.991
Depression	77	22.0	6	28.6	0.483
Osteoporosis	21	6.0	3	14.3	0.134
Smoker, n	37	10.6	5	23.8	0.063
Dominant presenting symptom, n					0.079
Back pain dominant	172	49.1	8	38.1	
Leg pain dominant	74	21.1	2	9.5	
Back pain = leg pain	104	29.7	11	52.4	
Motor deficit present at presentation, n	69	19.8	4	19.1	0.940
Independently ambulatory, n	303	88.1	17	81.0	0.467
Symptom duration, n					0.391
<3 mo	7	2.0	1	4.8	
>3 mo	330	94.3	19	90.5	
ASA class, n					0.845
I and II	210	60.0	13	61.9	
IIII and IV	118	33.7	8	38.1	
Hispanic or Latino ethnicity, n	22	6.3	2	9.5	0.558
≥4 y of college education, n	147	42.1	14	66.7	0.027*
Employed, n	179	54.3	10	47.6	0.754
Surgical variables					
Fusion	281	80.3	18	85.7	0.541
MIS-technique used	128	36.6	7	33.3	0.764
Mean baseline ODI	45.6	17.6	49.6	12.6	0.310
Mean baseline NRS back pain score	6.8	2.8	7.0	2.0	0.748
Mean baseline NRS Leg Pain score	6.5	2.9	6.2	2.6	0.915
Mean baseline EQ-5D score	0.55	0.22	0.53	0.21	0.709

ASA indicates American Society of Anesthesiologists; BMI, body mass index; EQ-5D, EuroQol-5 Dimensions; MIS, minimally invasive surgery; NRS-BP, Numeric Rating Scale Back Pain; NRS-LP, Numeric Rating Sale Leg Pain; ODI, Oswestry Disability Index; SD, standard deviation.

Mean values are presented with SD.

Statistically significant $P < 0.05$.

studies that have investigated the impact of resident involvement in spine surgery independent of time of year have found an association of resident involvement and longer operative times.[29–36] Our results suggest that this may be most pronounced with the introduction of new trainees in July. Although some previous investigations have attributed increased perioperative complications in resident cases to increased operative time,[29–32] we did not find that our increase in operative time in July was associated with any clinically relevant short-term or long-term outcomes.

Indeed, the lack of an observed "July Effect" for every other outcome measure may be a reflection of increased attending supervision earlier in the year.[37] This is consistent with previous investigations that do not support the presence of a July effect in spine surgery.[12,13,15,38] Previous reports have focused on mortality, postoperative complications, and intraoperative factors in a variety of spine cases involving residents and some have taken into account the complexity of the case as well. Similarly, an NIS study of adult spinal deformity surgery found no increase in complications or inpatient mortality during the month of July.[12] This is also supported by studies outside of the confines of the NIS. In a retrospective analysis of a prospectively maintained multicenter database, Hoashi *et al*[13] did not appreciate a significant difference in length of stay, intraoperative blood loss, operative time, total complications, or major complications between patients with adolescent idiopathic scoliosis undergoing surgery for in July compared to other months. In a single-institution study assessing the rates of postoperative infections in patients at a spinal cord injury

TABLE 2. Univariate Analysis of Perioperative Outcomes

	Non-July (n = 350)	SD or %	July (n = 21)	SD or %	*P*
Mean EBL, mL	169.0	190.5	199.3	142.6	0.475
Mean operative time, mins	186.0	81.6	200.7	73.2	0.421
Mean length of hospitalization, days	2.8	1.6	2.7	1.2	0.745
Discharge disposition					
Home or home health care, n	320	92.2	21	100	0.397
Readmission within 90 days, n	5	1.4	0	0	>0.999
Reoperation within 36 mo, n	16	4.6	0	0	0.613
Any complication, n	27	7.7	1	4.8	0.619
DVT, PE	0		0		
Neurologic deficit	5	1.4	1	4.8	0.240
Myocardial infarction	1	0.3	0	0	>0.999
Urinary tract infection	4	1.1	0	0	>0.999
Surgical site infection	5	1.4	0	0	>0.999
Hematoma	2	0.6	0	0	>0.999
Cerebrovascular accident	0	0	0	0	
Durotomy	10	2.9	0	0	>0.999
Pneumonia	0	0	0	0	

DVT indicates deep vein thrombosis; EBL, estimated blood loss; PE, pulmonary embolism; SD, standard deviation.
Mean values are presented with SD.

center over a 4-year period, no "July Effect" was observed (rather worse outcomes were observed in January), despite a hypothesized increase in operative and tissue-handling time associated with new resident trainees.[38] Another study examined the rate of serious adverse events in patients undergoing a variety of spine surgeries at academic medical centers using the ACS National Surgical Quality Improvement Program (ACS NSQIP). This study found no difference

TABLE 3. Univariate Analysis of Patient-reported Outcomes

	Non-July (n = 350)	SD or %	July (n = 21)	SD or %	*P*
ODI					
Baseline	45.6	18.6	49.6	12.6	0.310
24 mo	18.3	18.6	18.2	17.0	0.995
Change (−)	26.5	21.6	29.3	20.2	0.601
NRS-BP					
Baseline	6.8	2.8	7.0	2.0	0.748
24 mo	2.9	3.0	2.5	2.6	0.557
Change (−)	3.8	3.3	4.2	2.4	0.657
NRS-LP					
Baseline	6.6	2.9	6.6	2.6	0.915
24 mo	2.2	3.0	1.1	1.7	0.134
Change (−)	4.3	3.9	5.2	2.9	0.302
EQ-5D					
Baseline	0.55	0.22	0.53	0.21	0.709
24 mo	0.79	0.20	0.77	0.19	0.680
Change (+)	0.23	0.25	0.21	0.22	0.719
NASS Satisfaction at 24 mo	N = 286		N = 16		0.762*
1	200	69.9	14	87.5	
2	57	19.9	0	0.0	
3	11	3.9	1	6.3	
4	18	6.3	1	6.3	

EQ-5D indicates EuroQol-5 Dimensions; ODI, Oswestry Disability Index; NASS, North American Spine Society; NRS-BP, Numeric Rating Scale Back Pain; NRS-LP, Numeric Rating Scale Leg Pain; SD, standard deviation.
Mean values are presented with SD.
*χ^2 comparison for groupings NASS 1 and 2 vs. 3 and 4.

TABLE 4. Propensity Score-Matched Analysis of Postoperative Outcomes Between Non-July and July Cohorts

Outcome	ATE	CI	*P*
EBL, mL	37.3	−53.6 to 128.1	0.421
Length of surgery, min	22.4	0.9 to 449.0	0.041*
Length of stay, days	−0.3	−0.8 to 0.2	0.241
Change in PRO score at 24 mo			
ODI	4.0	−5.5 to 13.6	0.407
NRS-BP	0.09	−1.0 to 1.1	0.862
NRS-LP	1.0	−0.5 to 2.5	0.174
EQ-5D	−0.01	−0.09 to 0.08	0.902
NASS Satisfaction at 24 mo	−0.1	−0.6 to 0.5	0.872

ATE indicates average treatment effect; CI, confidence interval; EBL, estimated blood loss; EQ-5D, EuroQol-5 Dimensions; NASS, North American Spine Society; NRS-BP, Numeric Rating Scale Back Pain; NRS-LP, Numeric Rating Scale Leg Pain; ODI, Oswestry Disability Index; PRO, patient-reported outcome.

in the incidence of adverse events between the first academic quarter and the rest of the year.[15] Of note, there was a significant difference in the incidence of adverse events between cases involving residents and those without residents during the entire academic year but this was likely confounded by the residents being involved in cases with a higher degree of complexity.

On the contrary, other studies report somewhat mixed findings.[10,14] McDonald *et al*[10] queried the NIS database from 2001 to 2008 to study outcomes for patients undergoing spinal surgery in the month of July. The authors found no difference in likelihood of in-hospital mortality or postoperative complications between July admissions and all other month admissions; however, they describe a higher likelihood of discharge to long-term care facility and postoperative infection in July surgeries. One study, which queried the NIS database for patients undergoing anterior cervical fusion from 2009 to 2011, found July admissions at teaching hospitals had longer lengths of stay (but no significant differences in mortality or total hospital costs) compared to nonteaching hospitals. The authors describe a greater length of stay and higher prevalence of postoperative dysphagia, surgical site infection, and DVT among July admissions in teaching hospitals compared to nonteaching hospitals.[14] In contrast, we did not observe a difference in SSI and DVT rates between July and non-July surgeries.

In contrast, some investigations have appreciated a clear "July Effect" in spine surgery. Dasenbrock *et al*[11] describe higher rates of in-hospital mortality and intraoperative complications for patients with metastatic spinal disease undergoing spinal surgery in the month of July. This observation may be partially attributable to the medically complex nature of this patient population. Although attempts have been made to account for differential illness severity of patients admitted to academic *versus* nonacademic hospitals, it remains difficult to assess the extent to which a "July Effect" is confounded by academic medical centers assuming responsibility for overall sicker patients.[10,35]

Given the responsibility of academic hospitals to provide resident education while also delivering quality care, it is important to understand the impact of academic year transitions. To this effect, the Accreditation Council of Graduate Medical Education (ACGME) placed new supervision standards in 2011, explicitly delineating "direct" and "indirect" supervision.[39] The lack of a "July Effect" may be attributable to safeguards put in place at academic hospitals to prevent errors that may be attributable to less experienced trainees. For example, at some centers, there is an overlap between the resident transition in July and the end of the spine fellowship position from the previous academic year. At others, attendings—anticipating the transition period—may assume a greater "hands-on" role—both intraoperatively and clinically—in July. This serves to provide newly promoted residents an experienced team member to guide clinical and surgical care during the transition period in July. Another safeguard inherent to medical teaching is the increased responsibility assumed by senior residents earlier in the academic year. Moreover, the lack of a "July Effect" in spine specifically may be explained by the fact that these patients are cared for by a multidisciplinary team—not just surgeons (*e.g.*, advanced practice providers)—which may compensate for the lack of experience of the July residents. Though we must continue to be vigilant in facilitating safe and efficacious patient care during the transition period into a new academic year, it may prove reassuring that the current measures in place are associated with non-inferior patient outcomes at the high-volume teaching centers studied in the prospective QOD registry. Of note, in direct queries of each participating site in the current investigation, we found no formal protocols that were instituted in the month of July during the study period. However, most sites reported that post-graduate year 1 residents (interns) received extensive onboarding and training (*e.g.*, in operative simulation and suturing laboratories). Furthermore, multiple sites noted that it was understood that senior residents and attendings would provide closer supervision during the start of a new academic year.

The present study's strength lies in its reporting of spine-specific PROs. PROs are now considered the gold-standard for measuring success in spine surgery and our finding of a lack of difference in these measures suggests that the introduction of new trainees in July does not impact the clinical effectiveness of spine surgery. Many previous studies do not have adequate follow-up to accurately judge the quality of spine care received. Instead, studies using the NIS and ACS NSQIP are limited in information pertaining to inpatient stays and a 30-day postoperative period, respectively.[40] Neither database is able to assess spine-specific clinical outcomes such as functional status; moreover, they rely on administrative data as a proxy for quality of care delivered as opposed to actual patient-centered outcomes (*e.g.*, disability, back pain, leg pain, quality of life, satisfaction). Additionally, these databases are retrospective in nature and therefore are subject to lack of standardization of disease-specific variables. The QOD spondylolisthesis database is a prospective spine-specific registry, which allows for more accurate characterization of spinal disease states.[17] Because our study examines the "July Effect" on spine-specific PRO metrics—not just survivability and morbidity—it is directly relevant to patients.

Limitations

There are several limitations to this study stemming from the retrospective analysis of a prospective multicenter registry. Although we analyzed centers with residency training programs, it is not possible to assess the extent of resident involvement in the index surgeries. Furthermore, we are unable to standardize the post-graduate year of the residents involved in cases and the extent of attending surgeon involvement in each case. Similarly, we are unable to determine the degree and level of supervision retrospectively. Additionally, in this cohort, fewer cases were conducted during July, compared to other months of the year. This may reflect a unique environment during July, as attending surgeons may conduct fewer cases to ensure heightened resident supervision. Lastly, the cohort undergoing surgery in July was more likely to have completed $\geq$4 years of college. Indeed, this may reflect a subset of patients with higher medical literacy and less physical, labor-intensive occupations.[41] These factors may result in a surgical candidate with more accurate preoperative expectations and who is able to adhere to postoperative restrictions—both possibly contributing to improved outcomes.[42,43] Increased attending supervision with a lower caseload and a higher patient education level may potentially mitigate a "July Effect" if present. However, we attempt to correct for possible confounders using a propensity-matched analysis. Future studies may study the impact of these factors on surgical outcomes as they pertain to the "July Effect". Nonetheless, this study represents one of the largest multi-institutional, prospective studies examining the presence of a "July Effect" in spine surgery.

CONCLUSION

In adjusted analyses, although July surgeries were associated with longer operative times, they were not associated with significantly different clinical outcomes—including long-term PROs—from non-July surgeries following lumbar spondylolisthesis surgery at spine surgical centers with resident trainees. There is no evidence that the influx of new trainees in July significantly affects long-term, patient-centered spine surgical outcomes.

➢ Key Points

- ❑ We utilized the QOD registry to investigate 608 patients who underwent single-segment surgery for grade 1 degenerative lumbar spondylolisthesis at QOD spondylolisthesis module sites with residency trainees. Surgeries were classified as occurring in July or not in July.
- ❑ In propensity score-matched analyses, July surgeries were associated with longer operative times.
- ❑ July surgeries were not associated with significantly different outcomes for estimated blood loss, length of stay, discharge disposition, postoperative complications, overall reoperation rates, 3-month readmission rates, and 24-month ODI, NRS back pain, NRS leg pain, EQ-5D, and NASS satisfaction scores.
- ❑ There is no evidence that the influx of new trainees in July significantly affects long-term patient-centered outcomes.

Acknowledgments

The authors thank all of the site research coordinators for their help with data extraction and validation. We would also like to thank the Neurosurgery Research and Education Foundation for its financial support of this work.

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