Comparison of a Posterior versus Anterior Approach for Lumbar Interbody Fusion Surgery Based on Relative Value Units

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ABSTRACT

Introduction: The current value-driven healthcare system encourages physicians to continuously optimize the value of the services they provide. Relative value units (RVUs) serve as the basis of a reimbursement model linking the concept that as the effort and value of services provided to patient’s increases, physician reimbursement should increase proportionately. Spine surgery is particularly affected by these factors as there are multiple ways to achieve similar outcomes, some of which require more time, effort, and risk. Specifically, as the trend of spinal interbody fusion has increased over the past decade, the optimal approach to use—posterior versus anterior lumbar interbody fusion (PLIF vs. ALIF)—has been a source of controversy. Due to potential discrepancies in effort, one factor to consider is the correlation between RVUs and the time needed to perform a procedure. Therefore, the purpose of this study was to compare: 1) mean RVUs; 2) mean operative time; and 3) mean RVUs per unit of time between PLIF and ALIF with the utilization of a national surgical database. We also performed an individual surgeon cost benefit analysis for performing PLIF versus ALIF.

Materials and Methods: The American College of Surgeons National Surgical Quality Improvement Program (ACS NSQIP) database was utilized to identify 6,834 patients who underwent PLIF (CPT code: 22630) and 6,985 patients who underwent ALIF (CPT code: 22558) between 2008 and 2015. The mean operative times (in minutes), mean RVUs, and RVUs per minute were calculated and compared using the Student’s t-tests. In addition, the reimbursement amount (in dollars) per minute, case, day, and year for an individual surgeon performing PLIF versus ALIF were also calculated and compared. A p-value of less than 0.05 was used as the threshold for statistical significance.

Results: Compared to ALIF cases, PLIF cases had longer mean operative times (203 vs. 212 minutes, p<0.001). However, PLIF cases were assigned lower mean RVUs than ALIF cases (22.08 vs. 23.52, p<0.001). Furthermore, PLIF had a lower mean RVU/minutes than ALIF cases (0.126 vs. 0.154, p<0.001). The reimbursement amounts calculated for PLIF versus ALIF were: $4.52 versus $5.53 per minute, $958.66 versus $1,121.95 per case, and $2,875.98 versus $3,365.86 per day. The annual cost difference was $78,380.92.

Conclusion: The data from this study indicates a potentially greater annual compensation of nearly $80,000 for performing ALIF as opposed to PLIF due to a higher “hourly rate” for ALIF as is noted by the significantly greater RVU per minute (0.154 vs. 0.126 RVU/minutes). These results can be used by spine surgeons to design more appropriate compensation effective practices while still providing quality care.
work, 2) practice expense, and 3) malpractice expense. Each of these three factors are measured in terms of relative value units (RVUs) that are summed together to yield a total RVU of a particular service or procedure. Physic work is intended to directly reflect the time, effort, and technical skill required by the physician to provide the service and comprises approximately half of the total RVU. As a result, a service that requires more work should be assigned a higher RVU, ultimately leading to greater compensation. However, numerous studies have brought into question the accuracy with which RVUs correlate with empirically-measured time and effort.

Over the past few decades, as the frequency of spinal fusions has increased, controversy has arisen as to which approach is optimal: posterior versus anterior lumbar interbody fusion (PLIF vs. ALIF). In general, PLIF has been found to require increased operative times and lengths of stay, but ALIF has been associated with increased rates of complications and reoperations. Furthermore, while the more traditional posterior approach is associated with lower complication rates, it can be restricted by the thecal sac as well as potential iatrogenic injury to the spinal musculature and nerves. On the other hand, while the anterior approach can avoid some high-risk anatomy, the anterior vascular anatomy becomes the new concern. Because of the vascular anatomy, this approach may then involve either a general or vascular surgeon for the initial anterior approach. Nevertheless, both procedures carry good success rates—over 90,000 cases are performed annually. Since both procedures carry similar clinical outcomes, one factor that may be considered when deciding between PLIF versus ALIF is the correlation between the effort involved and effort recognized by the RVU system. Therefore, the purpose of this study was to determine whether RVUs adequately capture the complexity, technical skill, and aftercare required in PLIF versus ALIF. Specifically, we compared: 1) mean RVUs; 2) mean operative times; and 3) RVU per unit of time between PLIF and ALIF. We also extrapolated the data and performed an individual surgeon cost difference analysis for performing ALIF versus PLIF.

### Materials and Methods

#### Database

This study used the American College of Surgeons National Surgical Quality Improvement Program (ACS NSQIP) database to identify all cases of PLIF and ALIF performed between 2008 and 2015. This nationally-validated database provides hospitals and surgeons with high-quality data so as to help prevent complications, reduce costs, and improve patient outcomes. This data is prospectively collected from the time of hospital admission to 30 days postoperatively by hospital-specific Surgical Clinical Reviewers and includes numerous metrics, such as Current Procedural Terminology (CPT) codes, operative times, and relative value units. Because the database contained de-identified data, this study was deemed exempt by the Institutional Review Board (IRB).

#### Current procedural terminology (CPT) codes

Current procedural terminology (CPT) codes are part of a universal system maintained by the American Medical Association (AMA) used to identify discrete medical, surgical, and laboratory services. These codes are used to link different patient services to physician reimbursement and falls within three categories. Category I CPT codes are directly linked to procedures or services performed by a physician and were used in this study. Meanwhile, Category II CPT codes are optionally used for supplemental tracking, and Category III CPT codes are provisionally used for new technologies, procedures, or services. Specifically, CPT Code 22630 codes for “arthrodesis, posterior interbody technique, including laminectomy and/or discectomy to prepare interspace (other than for decompression), single interspace: lumbar,” was used to identify PLIF cases. CPT Code 22558 codes for “arthrodesis, anterior interbody technique, including minimal discectomy to prepare interspace (other than for decompression) lumbar,” was used to identify ALIF.

#### Relative value units analysis

Variable name “WORKRVU” was used to identify the work RVUs, which defined the RVU analyzed in this study. Relative value units are specific to a discrete patient service and particular CPT codes, and their values are continuously updated by the CMS no less than every five years. However, RVUs may still be re-evaluated and adjusted within a shorter timespan for services that are considered unfairly valued. For such changes to occur, physicians in a particular field must first complete surveys that address the time, effort, and costs required to perform individual services and procedures. The AMA/Specialty Society Relative Value Scale Update Committee (RUC) can then use these survey results to develop and propose new recommendations for review by the CMS. The CMS can decide whether to adopt these changes and update the RVUs.

#### Mean operative time analysis

Variable name “OPTIME” was initially used to identify the operative time (in minutes) for all cases of PLIF and ALIF. To account for potential errors in data collection, operative times of less than 60 minutes or greater than 630 minutes were not included, resulting in the exclusion of a small number of cases and inclusion of over 95% of the available data. Furthermore, the accuracy and up-to-date nature of the database and use of over 10,000 total data points provides for a fair and representative analysis of the patient population at-large.

#### Posterior lumbar interbody fusion patient cohort

Category I CPT code 22630 was used to initially identify 6,964 cases of PLIF. However, 130 cases (2%) with operative times of less than 60 minutes or greater than 630 minutes were excluded, resulting in 6,834 (98%) cases that were included in the final analysis of this study. A total of 3,647 cases were women (53%), while 3,187 cases were men (47%). The mean age of the entire cohort was 58 years (range, 16 to 89 years).

#### Anterior lumbar interbody fusion patient cohort

Category I CPT code 22558 was used to initially identify 7,381 cases of ALIF. However, 396 cases (5%) with operative times of less than 60 minutes or greater than 630 minutes were excluded, resulting in 6,985 (95%) cases that were included in the final.
A total of 3,764 cases were women (54%), while 3,219 cases were men (46%). For two cases (0.03%), gender was not identified. The mean age of the entire cohort was 55 years (range, 19 to 89 years).

Annualized cost difference analysis
An annualized cost difference analysis was performed for an individual surgeon performing PLIF versus ALIF. Parameters of analysis included one operating room, a 10-hour workday, and 160 operative days per year (365 calendar days minus 104 weekend days, 19 vacation days and federal holidays, and one-third of the remaining days for clinical and other non-operative work). Based on the mean operative time for each cohort and the established parameters, an individual surgeon could (theoretically) complete either three PLIF or three ALIF cases per day. The CMS reports an RVU-to-dollar conversion factor of $35.8887/RVU. With this conversion factor and the mean RVU/minutes for each cohort, the per-minute reimbursements for PLIF and ALIF were calculated. Next, the per-case reimbursement amounts were calculated from these values using the mean operative time for each cohort. The mean daily reimbursement was calculated by multiplying the per-case reimbursements by the number of cases completed per day (3 PLIF or 3 ALIF). Finally, the difference in daily reimbursement was calculated and extrapolated over 160 operative days to determine the annualized cost difference.

Mean relative value units
The mean RVU for the 6,834 PLIF cases was 22.08 ± 0.05 (range: 21.89 to 22.09). The mean RVU for the 6,985 ALIF cases was 23.52 ± 0.04 (range: 23.33 to 23.53). Therefore, the mean RVU for PLIF was found to be significantly less than that for ALIF (p<0.001).

Mean operative times
The mean operative time for the 6,834 PLIF cases was 212 ± 95 minutes (range: 60 to 630 minutes). The mean operative time for the 6,985 ALIF cases was 203 ± 113 minutes (range: 60 to 630 minutes). Therefore, the mean operative time for PLIF was found to be significantly greater than that for ALIF (p<0.001).

Mean RVU/minute
The mean RVU/minute for the 6,834 PLIF cases was 0.126 ± 0.06 (range: 0.04 to 0.37), while the mean RVU/minute for the 6,985 ALIF cases was 0.154 ± 0.08 (range: 0.04 to 0.39). Therefore, the mean RVU/minute for PLIF was found to be significantly less than that for ALIF (p<0.001).

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| Table I |
| PLIF vs. ALIF |
| Total (N) | PLIF | Mean (range, SD) | ALIF | Mean (range, SD) | P-value |
| RVU | | | | | |
| Time (minutes) | 22.08 (21.89 to 22.09; SD: 0.047) | 23.52 (23.33 to 23.53; SD: 0.038) | p<0.001 |
| RVU/minute | 0.126 (0.04 to 0.37; SD 0.058) | 0.154 (0.04 to 0.39; SD 0.081) | p<0.001 |

| Table II |
| Annualized cost analysis for PLIF vs. ALIF |
| PLIF | ALIF |
| RVU/minute | 0.126 | 0.154 |
| $/minute | $4.52 | $5.53 |
| $/case | $958.66 | $1,121.95 |
| Cases/day | 3 | 3 |
| $/day | $2,875.98 | $3,365.86 |
| Daily cost difference | $489.88 |
| Annualized cost difference | $78,380.92 |
minutes, PLIF was found to be reimbursed at $958.66 per case, yielding a daily accrual of $2,875.98 for completing three cases in a 10-hour day. Based on a mean operative time of 203 minutes, ALIF was found to be reimbursed at $1,114.67 per case, yielding a daily reimbursement difference of $78,380.92 disparity for an individual surgeon performing ALIF versus PLIF cases (Table II).

DISCUSSION

Nearly two decades ago, CMS implemented the RBRVS as a way to control healthcare costs by optimizing the value of physician-provided care.15 Under the RBRVS, RVUs were created as a way to correlate the value of procedures and services to physician reimbursement.16 As the debate between the most optimal approach for interbody fusion continues, one factor that must be considered are RVUs. Therefore, the purpose of this study was to determine whether RVUs adequately capture the work required by PLIF versus ALIF by comparing mean RVUs, mean operative times, and RVU per unit of time. We found that, despite its shorter mean operative time (203 vs. 212 minutes, p<0.001), ALIF was assigned higher mean RVUs (23.52 vs. 22.08, p<0.001). Consequently, there is a higher mean RVU/minute (0.154 vs. 0.126, p<0.001) for ALIF. When extrapolated to an annual cost, a reimbursement difference of nearly $80,000 was found. This cost difference, however, needs to be balanced against potential cost sharing as many times during ALIF, other surgeons, such as vascular or general, are consulted to help reduce possible vascular injury.37

Anterior and posterior approaches are two of the most common techniques for performing lumbar interbody fusions (LIF). As this procedure has become more prevalent in spine practices, a dispute has arisen as to which of the two approaches is optimal.38 Our findings indicated that, although PLIF was assigned a lower RVU, it required more physician work as reflected by an increased mean operative time. In a similar fashion, Pradhan et al.39 performed a retrospective review comparing several metrics and found that PLIF resulted in a longer operative time and length of stay. Moreover, PLIF required greater blood transfusion and was associated with lower rates of morbidity than ALIF. In a later study by Freudenberger et al.,38 PLIF was again found to result in greater blood loss and required a longer operative time. These findings suggest that PLIF requires increased time and effort on the part of the physician and hospital staff both intraoperatively and postoperatively. Focusing on long-term outcomes, Huang et al.38 examined healthcare utilization by patients with a minimum two-year follow-up and found that PLIF patients incurred lower rates of reoperation and decreased postoperative costs. In addition, Fineberg et al.38 reported lower rates of postoperative ileus and other complications in association with PLIF versus ALIF (26.0 vs. 74.9 per 1000, p<0.001). These findings suggest that PLIF may provide better outcomes and value.

There were some limitations in this study. We utilized a retrospective cohort design such that our analysis was limited to the data contained within the ACS NSQIP database. However, this study utilized over 10,000 data points drawn from a national database, thereby allowing for better representative analysis of the true patient population. Another limitation may be the ability to apply the results of this study to the practice of an individual surgeon at an academic center versus a community hospital. However, given that the database was prospectively compiled from a wide range of surgical centers, we believe the results may be more easily generalized than if the study utilized data from a particular hospital or setting. In addition, cases with operative times of less than 60 minutes or greater than 630 minutes were excluded from this study. However, these only constituted a small number of cases (approximately 0.8%) and were likely due to error in coding. Furthermore, there are a number of other methods for interbody fusion, such as lateral lumbar interbody fusion (LLIF) and a minimally invasive technique. Also, PLIF and transforaminal lumbar interbody fusions are coded under the same CPT code, and we were unable to distinguish the two procedures; however, they are both performed through posterior approaches.38 Future studies should be conducted in a similar manner as this study to identify any potential compensation discrepancies among these procedures and with consideration to ALIF and PLIF. Several studies have analyzed the relationship between physician work and RVU with similar outcomes. Shah et al.39 utilized the ACS NSQIP database to examine various metrics of physician work for eleven high-volume surgical procedures, revealing that RVUs poorly correlated with length of stay, intraoperative time, and mortality. Likewise, Schwartz et al.40 also queried the ACS NSQIP database to compare acute care surgery in the elective versus emergent settings. Surveys of biliary, colorectal, and hernia procedures showed that, despite having similar RVUs, emergent care was associated with longer lengths of stay and higher rates of complication and readmission, all of which require greater physician time and effort. Three studies examined the accuracy of the RVU assignment of the newly coded minimally invasive sacroiliac joint fusion (MI SIJF) procedure. There have been similar studies that contrasted MI SIJF with the presumably comparable lumbar discectomy (L.D) procedure.41 Through this comparison, Garber et al.33 found that despite a lower RVU assignment (9.03 vs. 13.18), MI SIJF had a similar intraoperative time and required increased pre- and postoperative care as well as cognitive effort during surgery. Furthermore, Frank et al.23 extended these findings by unveiling that MI SIJF demanded increased pre- and postoperative times and intraoperative mental and physical intensity. Meanwhile, Lorio et al.24 surveyed two sets of spine surgeons to compare the effort required by MI SIJF relative to 27 comparator spine procedures. Based on Rasch analysis of the survey results, they found MI SIJF to be significantly under-valued compared to the work RVUs derived from both the first set of responses (9.03 vs. 14.36) and the second set of responses (9.03 vs. 14.1). Together, these studies demonstrated the failure of RVU assignments to adequately capture the time, technical skill, mental effort, and level of patient care required for MI SIJF.
examined the validity of RVUs in surgical procedures for congenital heart disease (CHD) and found correlations between RVUs and indicators such as lengths of stay, hospital charges, and mortality. However, CHD surgery is generally performed on a pediatric population with complex, often life-threatening conditions such that it may be difficult to generalize these results to adult LIF cases. Moreover, these findings were published nearly 20 years ago, during which time the RVU system has undergone multiple revisions. Another study by Little et al. analyzed common pediatric procedures and found correlations between intraoperative time and RVU, with those strongest for minimally-invasive surgeries followed by urological and general procedures. However, this study only included cases performed as outpatient or requiring less than one inpatient day with direct surgeon involvement. Therefore, the results may not be generalized to cases involving either adult patients or enhanced complexity as reflected by increased lengths of stay and postoperative care. Similar to our study, Nguyen et al. utilized the ACS NSQIP database to compare the RVU with outcomes of plastic surgery cases. Although their findings revealed positive relationships regarding total and surgical-site complications, the authors admit that the association with intraoperative time was limited and, in part, likely due to confounding factors.

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CONCLUSION

The results of this study found that ALIF was assigned a greater mean RVU, initially leading to expectations that this approach would be more labor-intensive, therefore requiring more operative time. However, further examination showed that ALIF actually required a shorter mean operative time, resulting in a higher “hourly wage” as reflected by the significantly higher mean RVU/minutes (0.154 vs. 0.126, p<0.001) when compared to PLIF. Extrapolation of these results to an annualized basis revealed that physicians who exclusively perform ALIF as opposed to PLIF stand to potentially gain an additional $80,000 per year. Given this discrepancy between RVU assignment and actual physician work, orthopaedic surgeons performing ALIF or PLIF may financially benefit by adjusting their procedural practices while still providing the same, if not improved, level of care.

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