EDITORIAL

Perioperative outcomes and adverse events of minimally invasive surgery during transforaminal lumbar interbody fusion/posterior lumbar interbody fusion**Robert F. Heary, MD,¹ and Michael G. Kaiser, MD²**¹Department of Neurosurgery, Rutgers New Jersey Medical School, Newark, New Jersey; and ²Neurological Surgery, Columbia University, New York, New York

GOLDSTEIN et al. performed a systematic review of the literature and a meta-analysis of the study results comparing acute perioperative outcomes and adverse event rates of minimally invasive surgery (MIS) versus open transforaminal lumbar interbody fusion (TLIF)/posterior lumbar interbody fusion (PLIF) surgery for degenerative lumbar disease.¹ The authors also summarized data pertaining to patient-reported outcomes, fusion status, and reoperation rates. From 3301 papers, 26 studies met the inclusion criteria for this analysis. Only 1 prospective randomized controlled trial (RCT) was included, whereas the remaining 25 were either prospective or retrospective comparative studies.

The authors have conducted a thorough and exhaustive review of the literature and are to be congratulated for incorporating measures outlined in the Meta-analysis of Observational Studies in Epidemiology (MOOSE) and Preferred Reporting Items for Systematic Reviews and Meta-analyses (PRISMA) guidelines for the performance and reporting of systematic reviews and meta-analyses. Utilizing the Grades of Recommendation, Assessment, Development, and Evaluation (GRADE) protocol, the strength of the included studies was designated as “low” and “very low” quality. By pooling populations among these studies, data from more than 800 patients in each treatment cohort were analyzed. Although no significant difference in operative time was identified, estimated blood loss, time to ambulation, and length of hospital stay all favored MIS techniques. Adverse event rates were similar between the two groups; however, the incidence of medical complications was higher in the open cohort. No

differences in the rates of nonunion or reoperation were identified. Both patient populations demonstrated improved outcomes; however, a small, but significantly superior, improvement in ODI scores was observed following MIS procedures.

As with any literature review, this study is limited by the strength and quality of the data analyzed. Compared to other reviews, this investigation benefits from the inclusion of only comparative studies and the thorough analysis of methodological quality. Heterogeneity among patients, small sample sizes, lack of consistent reporting, and subjective treatment allocation are among the major limitations that introduce bias in these studies reviewed. Without well-designed RCTs, it is possible that an apples-to-oranges situation exists wherein the less difficult cases would be treated with MIS procedures. This could certainly impact patient outcomes and compromise the validity of any analysis. In addition, the definition of MIS techniques is often ambiguous in many of these studies.

A potential issue is that authors are writing articles comparing the newer MIS techniques versus the older open procedures, and as such, there may be a bias towards demonstrating more favorable outcomes for the newer MIS procedures. Although not clearly identified in this review, major concerns regarding studies analyzing MIS procedures have been the duration of follow-up and method, or lack of, fusion assessment.

Despite substantial limitations in the available literature on this topic, the authors have done an excellent job of summarizing the available data and providing a thoughtful discussion. Their conclusion, that a well-designed,

multicenter RCT utilizing validated outcomes measures is needed to perform a valid comparison of these two approaches, is well supported.

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Reference

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Disclosure

The authors report no conflict of interest.

Response

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Thank you for the opportunity to respond to this issue's editorial by Dr. Heary and Dr. Kaiser regarding our submission "Perioperative outcomes and adverse events of minimally invasive versus open posterior lumbar fusion: meta-analysis and systematic review."

While very complimentary of our study methodology, Drs. Heary and Kaiser appropriately point out that the quality of the results and ability to draw conclusions in systematic reviews and meta-analyses are limited by the quality of the included studies. Our adherence to MOOSE and PRISMA guidelines and transparent reporting of the results of our GRADE quality assessment of the 26 studies included in our review in no way eradicates this limitation; instead, it simply functions to educate the reader and facilitate reproduction of our results.

Regarding the concerns raised about comparing new MIS techniques to older open procedures, the majority of the included studies compared concurrent open and MIS cohorts. Three studies failed to report the time period of data collection for either of their treatment groups.^{3,10,11} Scheufler et al.⁹ reported the inclusion period of their MIS cohort, but did not report whether the open cohort was historical or concurrent, and Tsutsumimoto et al.¹² compared their MIS group to a historical open cohort. Although it is possible that some differences in care may have changed over time, which could have impacted the observed results, these studies represent only 16.6% of the open (n = 134) and 15.0% of the MIS (n = 138) cases. We therefore believe the impact of differences in treatment time periods on our study results would be minimal.

Heary and Kaiser also correctly point out that differences in duration of follow-up may impact our study results. Two of the included 26 papers failed to report their follow-up period,^{4,15} and 6 others reported differential follow-up times for the open and MIS cohorts.^{1,2,5,6,7,10} However, the ranges of follow-up for the open and MIS cohorts

in these 6 studies were fairly similar at 13.5 to 40 months and 14 to 32 months, respectively. The slightly longer follow-up duration in the open cohorts is certainly another potential source of bias; however, this can be bidirectional and differentially favor either cohort. Overall, given the clinically insignificant differences in patient reported outcomes between open surgery and MIS, it is unlikely that more uniform follow-up would have altered our conclusion of equivalent patient-reported outcomes at a median of 2 years following surgery.

Finally, it is also true that variability in fusion assessment methods may have impacted our study results. In the 8 studies reporting on fusion rates,^{1,3,5,6-8,13,14} 1 study failed to report their method of fusion assessment and the remaining 7 each used different methods of determining solid fusion. Although this introduces significant heterogeneity into the pooled nonunion rates presented in our meta-analysis, it should not impact the within-study comparisons given that for each comparative study the same method of fusion assessment was used in the open and MIS cohorts. Furthermore, fusion status may not impact the aggregate patient-reported outcomes for the duration of follow-up observed in the included studies.

Despite these and other limitations addressed in our paper, the greatest of which we believe is diagnostic heterogeneity, the results of our systematic review and meta-analysis represent the best available evidence regarding comparative outcomes of open versus minimally invasive techniques for transforaminal and posterior lumbar interbody fusion. Furthermore, our study serves to highlight that multicenter controlled studies, with appropriate diagnostic, clinical, and surgical stratification, are desperately required to definitively address the question of superiority of 1 technique over another.

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