

Peer Review File

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Reviewer A

This paper succinctly outlines a study exploring the safety and efficacy of a modified single-prone-lateral (mPL) positioning technique compared to the standard single-prone-lateral (sPL) position for lateral lumbar spine fusion surgery. The researchers conducted a cross-over cadaveric study, indicating a controlled and comparative experimental design.

The authors effectively convey the study's objectives, methods, and outcomes. It demonstrates the potential benefits of the novel mPL positioning approach in terms of safety and efficacy for lumbar spine fusion surgery, making it a valuable contribution to the field of medical research.

The key finding is the calculated odds ratio of 1.77 for a favorable outcome in position B (mPL) compared to position A (sPL), suggesting a significantly higher likelihood of success in the modified position. This is an important result, as it establishes the improved safety and efficacy of the mPL approach compared to the established sPL technique for lateral lumbar spine fusion.

This study's significance lies in its pioneering demonstration of the enhanced safety profile associated with the mPL positioning compared to the conventional sPL positioning for lateral lumbar spine fusion.

Below are my comments.

Comment 1: Was there radiological evaluation in mPL? Better, especially if there is an evaluation of PM on MRI and CT.

Reply 1: There was no radiological evaluation in the study. This is a limitation of the study, as it would be valuable to assess the mPL positioning technique's impact on postoperative radiographic outcomes, such as pedicle screw placement, foraminal decompression, and spinal alignment.

Changes in the text: Thank you very much for your feedback. This response is also included in the limitation section (Line 5-8).

Comment 2: While the mPL approach shows promising outcomes, how do you envision its implementation in clinical settings? Are there specific patient populations or types of lumbar pathologies for which the mPL approach might be particularly advantageous? For example, what about cases with lumbar rotation or scoliosis?

Reply 2: The study's first goal is to show the practicality of the mPL, particularly in the normal spinal alignment, with the goal of eventually using it in clinical settings. The mPL positioning approach, after a learning curve, might be used in clinical settings for lateral lumbar spine fusion in a number of patient demographics, including those with degenerative spondylolisthesis, spinal stenosis, and

spondylodiscitis. It may be especially beneficial for patients with complex lumbar pathologies, such as lumbar rotation or scoliosis, because the mPL positioning may allow for better access to the surgical site and more precise instrumentation placement with intraoperative neurophysiological monitoring (IONM).

Changes in the text: Thank you very much for your feedback. This response is also included in the discussion section (Line 14-22).

Comment 3: Given the positive results of the mPL approach, how do you anticipate this might impact the training and education of surgeons performing lateral lumbar spine fusion? Are there any specific skill sets or techniques that need to be emphasized to ensure safe and effective implementation of the mPL approach?

Reply 3: Thank you for your insightful feedback. I agree on this point. The mPL approach's favorable outcomes may lead to improvements in the training and education of surgeons doing lateral lumbar spine fusion. Surgeons must be familiar with the mPL placement approach, as well as its potential advantages and dangers. Surgeons should also be trained in the specialized skills and procedures necessary to perform the mPL approach safely and successfully, notably with the IONM or neuronavigation technology.

Comment 4: Patient anatomy can significantly vary. How do you account for potential variations in lumbar anatomy and patient characteristics that could impact the effectiveness and safety of the mPL approach? Are there any specific precautions or adaptations needed for cases with atypical anatomy?

Reply 4: Thank you for your insightful feedback. I agree on this point. Patient anatomy can vary significantly, and it is important to account for these variations when implementing the mPL positioning technique. In almost 70% of cases, the safe working zones for LLIF revealed that L4-L5 were accessible and instrumented.

Ref: Quack, V., Eschweiler, J., Prectel, C., et al. (2022). L4/5 accessibility for extreme lateral interbody fusion (XLIF): a radiological study. *Journal of Orthopaedic Surgery and Research*, 17, 483. <https://doi.org/10.1186/S13018-022-03320-0>

For example, patients with obesity or kyphosis may require additional IONM and neuronavigation to support and maintain a safe and comfortable position. Preoperatively, surgeons should be aware of any potential anatomical differences that may affect the surgical approach, such as thin pedicles or aberrant vascular structures.

Comment 5: Could you discuss any potential technical difficulties associated with adopting this technique and whether there is a learning curve for surgeons transitioning to the mPL approach? Does mPL have a learning curve compared to sPL? Which technique do you think is more difficult?

Reply 5: Thank you for your kind comments. On this issue, I agree. There are three potential technical difficulties associated with adopting the mPL positioning technique including i) the preoperative specific anatomy of key structures evaluation to aid in identifying cases at risk of complications ii) the need for specialized equipment, such as a lateral positioner and bolsters., and iii) the

requirement for additional IONM and neuronavigation to support and maintain a safe and comfortable position.

There is likely a learning curve for surgeons transitioning to the mPL approach. The mPL positioning technique is more complex than the sPL positioning technique, and it requires careful attention to detail to ensure patient safety and comfort. However, with experience, surgeons can become proficient in the mPL positioning technique. Overall, the mPL positioning technique is a promising new approach to lateral lumbar spine fusion surgery. It has the potential to improve safety and efficacy for patients with a variety of lumbar pathologies. However, more research is needed to assess the long-term outcomes of the mPL approach and to identify any potential risks or complications.

Reviewer B

Very interesting article.

Comment: However, the definition of good or bad outcomes are were not clear (at least for the reviewer), if the authors could, make the definition clear how this assessment was performed by the two reviewers it would be good.

Reply: Thank you for your input. I do agree and believe that the study should explain the definitions of good and negative outcomes in their article. Here are some definitions that may be used in the text:

Good outcome or **Favorable outcome** would be no nerve root damage and a successful fusion method.

Bad outcome or **Unfavorable outcome** would be nerve root damage and a failed fusion method.

The two raters in this study objectively decide the measured results. For example, the two raters concluded that the cadavers should be examined for signs of nerve root damage, such as nerve piercing or contacting.

Changes in the text: Thank you very much for your feedback. This response is also included in the discussion section (Line 11-15).

Reviewer C

Comment 1: Title: Unclear what the purpose of the study is about. Please try to modify to be more focused.

Reply 1: Thank you for your insightful feedback. I agree on this point. The title is changed to be:

Comparison of Standard and Modified Prone Positioning for Lateral Lumbar Spine Fusion: A Feasibility Study to Reduce Lumbar Plexus Injury

Changes in the text: The tile has been changed.

Comparison of Standard and Modified Prone Positioning for Lateral Lumbar Spine Fusion: A Feasibility Study to Reduce Lumbar Plexus Injury

Comment 2: Abstract: The abstract refers to the modified and standard approach to prone-lateral lumbar interbody fusion. It does not go into any detail on the

difference. I'm a firm believer that if the abstract was the only thing the reader read, then they would be able to come away with the main message(s). Please revise accordingly.

Reply 2: Thank you for your feedback. I agree on this point. The abstract has been modified to:

Background: Single-prone-lateral (PL) positioning is a new technique that has shown promising results in a wide range of lumbar diseases. The patient is put in a prone posture with the affected side raised and the ipsilateral arm above in the typical PL position. In this study, we focused on a modified version of the standard PL position with the goal of comparing the risk of lumbar plexus damage and the overall safety profile of the modified (mPL) and standard PL (sPL) configuration for lateral lumbar spine fusion surgery.

Methods: A cross-over soft cadaveric investigation was conducted, with two raters examining the comparative outcomes of position A: sPL and position B: mPL. The patient is put in a prone posture with the afflicted side raised and the ipsilateral arm at the side of the body in the mPL position. To assess positive results (no lumbar plexus injury) between locations A and B, a mixed effects logistic regression model was utilized. The chances ratio of a good result between locations B and A was also determined. The significance threshold was chosen at $p < 0.05$.

Results: The odds ratio of the favorable outcome between position B and A was 1.77, indicating significantly higher odds of a favorable outcome in the modified position B than in the control or position A.

Conclusion: In terms of safety and efficacy for lumbar spine fusion, the newly developed mPL positioning outperformed the sPL positioning. The mPL positioning may reduce the risk of lumbar plexus injury by allowing for a more direct approach to the lumbar spine and by avoiding excessive stretching of the lumbar plexus.

Changes in the text: The abstract has been modified.

Comment 3: Methods: Please explain the notion of the study design in further clarity for those unfamiliar with the formula.

Reply 3: This present study design is a cross-over soft cadaveric investigation. This means that each cadaver is used for both the modified and standard prone-lateral positioning techniques. The order of the techniques is randomized to avoid bias. This type of study design is commonly used in cadaveric studies because it allows for a direct comparison of two techniques on the same subject while minimizing the number of subjects required.

The formula used in the study is a logistic regression model to analyze data where there are both fixed and random effects. In this case, the fixed effect is the positioning technique (modified versus standard), and the random effect is the cadaver. The model is used to estimate the odds of a favorable outcome (no lumbar plexus damage) in the modified positioning technique compared to the standard positioning technique.

To interpret the odds ratio of 1.77, we can say that the modified positioning technique is 1.77 times more likely to result in a favorable outcome than the standard positioning technique. In other words, the modified positioning technique is associated with a 77% higher chance of avoiding lumbar plexus injury.

Overall, the study design and formula used are appropriate for the research question being asked. The cross-over design allows for a direct comparison of the two positioning techniques on the same subject while minimizing the number of subjects required. The mixed effects logistic regression model takes into account the random effect of the cadaver, which provides more accurate results.

The results of the study showed that the modified prone-lateral positioning technique was significantly more likely to result in a favorable outcome than the standard prone-lateral positioning technique. This suggests that the modified technique may be a safer and more effective approach to lateral lumbar spine fusion surgery.

The explanation of the study design for those unfamiliar with the formula:

- Each cadaver is used for both the modified and standard prone-lateral positioning techniques.
- The order of the techniques is randomized to avoid bias.
- Two raters evaluate the cadavers after each technique to see if there is any lumbar plexus damage.
- A statistical model is used to compare the two positioning techniques and determine which one is more likely to result in a favorable outcome (no lumbar plexus damage).

Changes in the text: The modified information is added in the methodology section including: **The statistical formula used in the study is a logistic regression model to analyze data where there are both fixed and random effects. In this case, the fixed effect is the positioning technique (modified versus standard), and the random effect is the cadaver. The model is used to estimate the odds of a favorable outcome (no lumbar plexus damage) in the modified positioning technique compared to the standard positioning technique (Line13-17).**

And Line 8-13 in Statistical analysis section

The description of the research design including:

- Each cadaver is used in both modified and standard prone-lateral postures.
- To avoid bias, the process sequence is randomized.
- Following each technique, two raters examine the cadavers to check whether there is any lumbar plexus damage. A statistical model is used to evaluate the two positioning processes and determine which one is more likely to have a positive outcome (no lumbar plexus injury).

Comment 4: The comment 'modified prone lateral position' seems incorrect. From the methods and the figure, it would seem the purpose is the modified (45deg oblique) position of prone lateral docking. The guide wire and subsequent dilators and retractor would be docked orthogonal thereafter.

Reply 4: Thank you for your input. The term "modified prone lateral position" is technically used, but it is not very specific. It is more accurate to describe the position as a "modified (45deg oblique) position of prone lateral docking." This means that the patient is placed in a prone position with the affected side elevated and the ipsilateral arm positioned overhead, but the patient is also rotated 45 degrees so that the spine is more aligned with the surgical table. This allows for a

more direct approach to the lumbar spine and may reduce the risk of lumbar plexus injury.

Comment 5: Table 1 does not add substantially to the figures and tables. please just place it into the body of the text.

Reply 5: I agree that Table 1 does not add substantially to the figures and tables and that it could be placed into the body of the text in the methodology section.

Changes in the text: The modified information is added in the methodology section (Line 18-20).

Comment 6: There is no mention of the guide wire distance to the location of the plexus or the L4 nerve root or the location of the guide wire relative to the disc space.

Reply 6: This is an excellent point. This information would be useful to add in the study since the raters attempted to figure out the evidence of guide wire piecing the nerve root, thus after the first rater placed the guide wire, the second rater dissected it and looked for nerve root injury. So the outcome was that there were four options: i) nerve root injury clearly with guide wire penetration, ii) nerve root was touching the guide wire closely, iii) the guide wire was distance from the nerve root, and iv) the rater could not find the relationship between the location of the nerve root and guide wire. it would provide more context for the results.

Changes in the text: The modified information is added in the discussion section (Line 15-20).

Comment 7: The concept of the study seems to be clear. If we obliqued the patient to 45deg to dock the retractor before disc prep, would that reduce the chance of the nerve injury. I believe the introduction and discussion section should reflect the purpose of the study more clearly by include the issues with nerve injury during transpsoas approach.

Reply 7: Thank you so much for your feedback. I agree that the introduction and discussion sections could be improved to reflect the purpose of the study more clearly and to include the issues with nerve injury during the transpsoas approach (Line 1-6 in the introduction section and Line 20-21 and Line 1-2 in the discussion section).