Comparative analysis of changes in spinal dimensions following different correction methods in adult spinal deformity surgery

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論文題目
Comparative analysis of changes in spinal dimensions following different correction methods in adult spinal deformity surgery
（成人脊椎変形手術における矯正方法の違いによる脊椎寸法変化の比較分析）

論文の内容の要旨
[Introduction]
Adult spinal deformity (ASD) is a spinal alignment abnormality in adulthood caused by scoliosis, degenerative disc disease, and other degenerative changes. As life expectancy rises, so does the prevalence of ASD, particularly in individuals over 60. Previous treatment methods focused on conservative management due to the higher operative risks involved. However, spinal corrective surgery has grown in popularity, leading to significant improvements in patient outcomes, including reduced pain and disability. Techniques such as posterior column osteotomies and minimally invasive methods, like lateral lumbar interbody fusion (LLIF), are used to manage ASD. LLIF offers advantages like reduced blood loss and improved spinal alignment without the need for direct neural decompression. This study aims to analyze three-dimensional (3D) changes in spinal canal length (SCL), anterior vertical column length (AVCL), and spinal canal volume (SCV) following ASD surgery using LLIF and posterior lumbar interbody fusion with multiple osteotomies (PLIF+MOs). The hypothesis is that LLIF results in more significant increases in spinal canal dimensions compared to PLIF+MOs.
[Materials and Methods]
This study was approved by the Ethics Committee of Hamamatsu University School of Medicine (approval number: 22-222), reviewed data from 274 ASD patients who underwent spinal correction surgery (LLIF or PLIF+MOs) between 2010 and 2021. Patients aged 18 and older, who required surgical intervention for pain or neurological deficits, were included. Those with a history of prior spinal surgeries, recent fractures, or incomplete medical records were excluded. Radiographic parameters, lumbar lordosis (LL), thoracic kyphosis (TK), pelvic tilt (PT), sagittal vertical axis (SVA), and Cobb angle, were measured pre- and postoperatively. All patients underwent full-spine computed tomography (CT) imaging before and after surgery. A 3D model was created to analyze spinal changes, with the AVCL measured from L1 to S1, and the SCL and SCV calculated from T1 to S1 using Synapse Vincent software.
For surgical correction, LLIF was used in patients without abdominal or vascular issues, while PLIF+MOs were performed in patients with severe deformities or high riding

iliac crests. LLIF involved a two-stage approach, starting with lateral transpsoas approach and followed by posterior corrective fusion. PLIF+MOs involved more invasive techniques, removing the lamina, facet joints, and ligaments for greater spinal flexibility.

[Results]

Out of 274 patients, 44 met the inclusion criteria, with 21 undergoing LLIF and 23 receiving PLIF+MOs. Patients in both groups had similar demographic characteristics, but significant differences in the number of fusion levels and T-scores were noted. Preoperative TK also differed between the groups.

Postoperative analysis revealed that LLIF increased AVCL (L1-S1) by 6.5 mm, while PLIF+MOs shortened it by 5.5 mm. LLIF also resulted in a 3.1% increase in SCL (whole spine T1-S1) and a 10.6% increase in SCV (whole spine T1-S1). Significant postoperative differences were noted between the two groups in terms of AVCL, SCL fusion levels, and spinal canal volume. Importantly, the changes in spinal dimensions did not translate into significant differences in postoperative Oswestry Disability Index (ODI) scores between the two groups.

[Discussion]

Previous studies using two-dimensional (2D) models to evaluate spinal canal dimensions in ASD surgery may fail to capture the complexity of spinal deformities, particularly in severe kyphoscoliosis. This study used a 3D model, providing a more accurate assessment of spinal canal changes. The results suggest that LLIF offers better correction of spinal canal length and volume compared to PLIF+MOs, potentially leading to more effective indirect decompression. This indirect decompression is advantageous in minimizing surgical risks, as it avoids direct manipulation of the spinal cord.

LLIF provided significant increases in spinal canal dimensions, particularly in SCL and SCV. This finding aligns with other studies showing that LLIF can improve foraminal height, intervertebral disc height, and central canal area. Conversely, PLIF+MOs, while offering greater flexibility for severe spinal deformities, did not achieve the same level of correction in spinal canal dimensions as LLIF.

The study highlighted the potential risks associated with spinal cord distraction during ASD surgery. Excessive distraction can lead to ischemic spinal cord injury, a risk that both techniques aim to mitigate. The increases in SCL observed in both groups align with previous studies, supporting the idea that careful surgical planning can minimize the risk of neurological complications.

[Conclusion]

This study compared the effects of LLIF and PLIF+MOs on spinal canal dimensions in patients undergoing ASD surgery. LLIF demonstrated superior increases in AVCL, SCL,

and SCV, suggesting it may offer better indirect decompression and spinal realignment in certain patient populations. While both techniques improved spinal alignment and canal dimensions, LLIF appeared more effective in enhancing spinal canal volume and length. These findings can inform surgical decision-making in ASD cases, particularly when prioritizing minimally invasive approaches that reduce complications while maximizing spinal correction.