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Comparison of Clinical and Functional Outcomes of Posterior Lumbar Interbody Fusion (PLIF), Lateral Lumbar Interbody Fusion (LLIF) and Posterolateral Fusion (PLIF) on Degenerative Spine Disease: A Systematic Review and Meta-Analysis

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ABSTRACT

Introduction: Posterolateral lumbar fusion (PLF) was once the predominant surgical approach, but its lack of anterior support, which affects spinal biomechanics, has limited its use. In response, the interbody approach, including posterior lumbar interbody fusion (PLIF) and lateral lumbar interbody fusion (LLIF), has been suggested as superior to the traditional method. the superiority of PLIF or LLIF over PLF remains a subject of debate

Methods: A systematic search using Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guideline was carried out to identify studies that were considered to be included in this meta-analysis review from 2015 to 2020. The outcomes assessed using forest plot were Visual Analogue Score (VAS) and Oswestry Disability Index (ODI) and this study systematically assessed clinical and radiological outcome

Results: This meta-analysis included a total number of 3377 patients with 1740 patients undergoing interbody fusion and 1637 patients undergoing PLF. The follow-up period was nearly similar between studies, ranging from one to two years post-operatively. The patient's age ranged from 50-85 years old.

Discussion: Meta-analyses found no significant differences in postoperative visual analog score (VAS) or Oswestry Disability Index (ODI) between PLF and interbody fusion groups. Variations in intraoperative blood loss between interbody and lateral fusion procedures are noted, potentially impacting surgical outcomes and complication rates, including neurological deficits and infections associated with interbody fusion techniques.

Conclusion: VAS and ODI outcomes were not significantly different between PLF and interbody fusion. However, PLF might provide better Cobb angle correction, meanwhile other outcome aspects were observed to be similar between the two groups.

Keywords: posterolateral lumbar fusion, interbody fusion, visual analogue score, Oswestry disability index.

INTRODUCTION

The spine, which provides structural support and protects neural elements while enabling trunk movement, is significantly impacted by degenerative changes. These changes can stem from minor mechanical injuries or larger traumas, such as spinal fractures and metabolic processes, leading to morphological alterations in all components of the spine, including the bones, intervertebral discs, joints, and ligaments. Lumbar degenerative disease, encompassing conditions like spondylolisthesis, disc degeneration, and spinal canal stenosis, causes substantial disability worldwide. These conditions result in common symptoms such as low back pain (LBP), weakness, and lower extremity pain, thereby diminishing the quality of life. Approximately 266 million people, or 3.63% of the global population, are estimated to suffer from lumbar degenerative spine disease (DSD) each year, with cases in low- and middle-income countries being nearly four times higher.2

These lumbar degenerative diseases can be managed either conservatively or surgically. The majority of patients with DSD can be treated conservatively when neurological impairment is minimal. However, if there is spinal destabilization and abnormal motion accompanied by progressive, disabling neurological deficits due to the degenerative process, surgical fusion may be considered to stabilize the spine. The rate of lumbar fusion surgeries has increased over time, with spondylolisthesis being the primary condition for most elective fusion surgeries. Despite its prevalence, this procedure remains controversial due to its various indications. Several factors must be considered when planning lumbar fusion surgery, including the patterns of spinal pathology, surgeon's preferences, patient characteristics, imaging results, surgical advancements, and potential overall costs.1,3 Posterolateral lumbar fusion (PLF) was once the predominant surgical approach, but its lack of anterior support, which affects spinal biomechanics, has limited its use. In response, the interbody approach, including posterior lumbar interbody fusion (PLIF) and lateral lumbar interbody fusion (LLIF), has been suggested as superior to the traditional method. This approach offers several advantages, such as indirect foraminal decompression, anterior column support, restoration of lordosis, and maintenance of intervertebral disc height. However, the superiority of PLIF or LLIF over PLF remains a subject of debate, as numerous studies have shown no significant difference between these interbody approaches and PLF 4. Based on the explanations cited above, this meta-analysis and systematic review aims to compare interbody fusion (PLIF, LLIF) and PLF as treatment for DSD regarding their clinical and functional outcomes.

MATERIAL AND METHODS

Search Strategy

A systematic search using Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guideline was carried out to identify studies that were considered to be included in this meta-analysis review from 2015 to 2020. Studies that compare PLIF and lateral fusion, not more than 5 years, study in English, and conducted on humans will be considered inclusion in research. The databases used included PubMed, ClinicalKey and Google Scholar. The focus in this meta-analysis is to compare the outcome of posterolateral fusion and interbody fusion in patients with degenerative spine diseases. Keywords in the search matched the MeSH rule and term used are ("PLIF") AND ("Lateral Fusion) AND ("Degenerative Spine Disease") AND ("Radiographic measurement") and ("PLIF") AND ("Lateral Fusion) AND ("Degenerative Spine Disease") AND ("Visual Analogue Score") and ("PLIF") AND ("Lateral Fusion) AND ("Degenerative Spine Disease") AND ("Oswestry Disability Index").[5]

Inclusion Criteria

Scholarly articles evaluating functional outcomes following PLIF or interbody fusion

were included in this study. The outcomes assessed using forest plot were Visual Analogue Score (VAS) and Oswestry Disability Index (ODI) and this study systematically assessed clinical and radiological outcome. Non-English studies, studies involving patients younger than 50 years of age and involving trauma or anything other than degenerative process as the cause of spine diseases were excluded.

Quality Evaluation

Assessment of study quality and risk of bias assessed using critical appraisal tools designed for use with systematic reviews and meta-analysis developed by the Critical Appraisal Skills Programme (CASP) and licensed under a Creative Commons Attributions-ShareAlike 4.0 International License. While the class of evidence is categorized into "class I" for good quality RCT, "class II" for moderate to poor quality RCT and good quality cohort, "class III" for moderate or poor-quality cohorts and case-control studies, "class IV" for the case series.

RESULTS

Literature Search, Study Selection and Study Characteristics

The electronic research resulted in 168 records from various databases. After the process of identification, screening, eligibility, duplication elimination, and exclusion, the remaining 8 studies were included in this meta-analysis, 4 studies for quantitative studies and 4 studies for quality studies. The remaining articles were excluded due to lack of mean and standard deviation data and did not meet the inclusion and exclusion criteria (Figure 1).

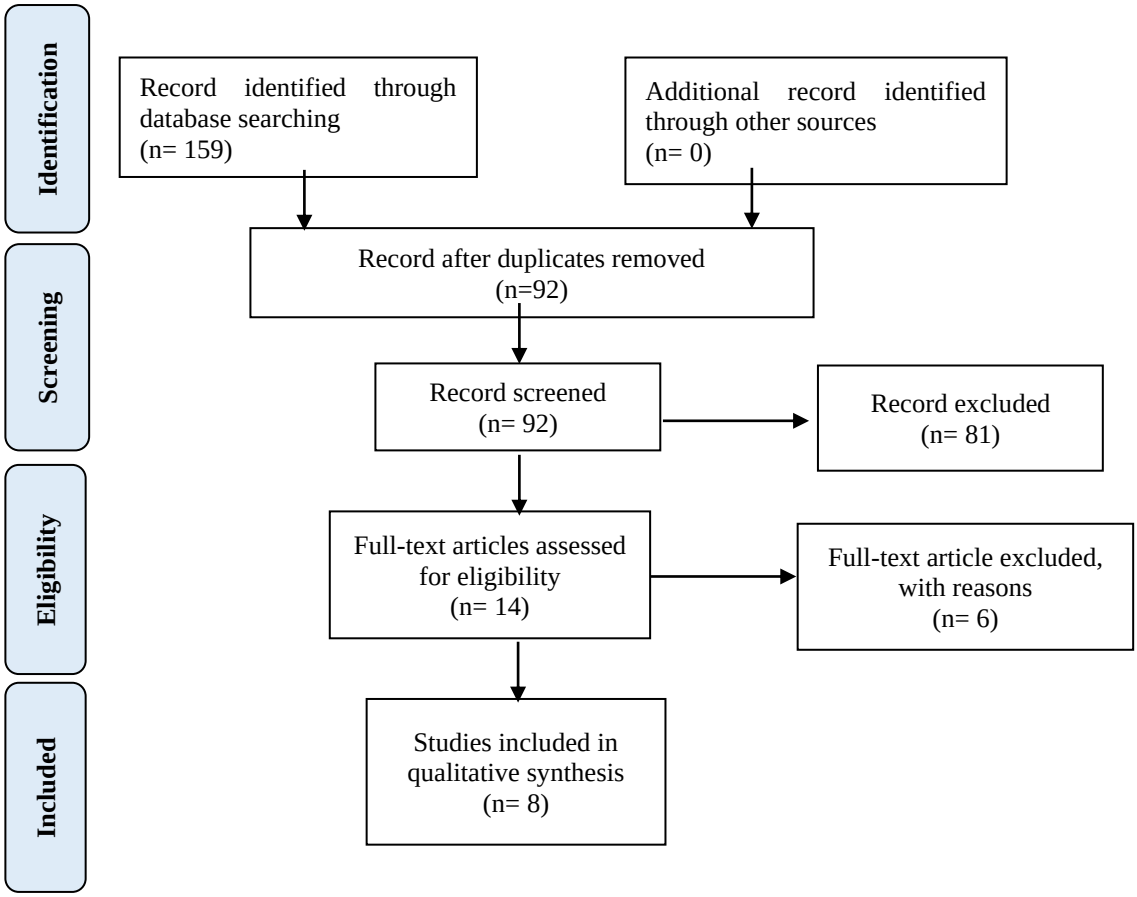

Figure 1 PRISMA Flow Chart

Table 3. Clinical Appraisal Skills Program (CASP) on included studies

CASP question	CASP 01. Clear statement of the research's aim	CASP 02. Appropriate methodology	CASP 03. Research design	CASP 04. Recruitment strategy appropriate with research's aim	CASP 05. Data collected in a way with research issue	CASP 06. Relationship between researcher and participants	CASP 07. Ethical issue	CASP 08. Sufficient data analysis	CASP 09. Clear statement finding	CASP 10. Research valuable
Challier *et al*, 2017	Y	Y	Y	Y	Y	N	N	Y	Y	Y
Nakashima *et al*, 2020	Y	Y	Y	Y	Y	Y	N	Y	Y	Y
Abdelaziz *et al*, 2019	Y	Y	Y	Y	Y	N	N	Y	Y	Y
Farrokhi *et al*, 2018	Y	Y	Y	Y	Y	N	N	Y	Y	Y
Shekhar *et al*, 2020	Y	Y	Y	Y	N	N	N	N	Y	N
Jalalpour *et al*, 2015	Y	Y	Y	Y	Y	Y	N	Y	Y	Y
Yijian *et al*, 2018	Y	Y	Y	Y	Y	Y	?	Y	Y	Y
Ye *et al*, 2019	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y

Outcome Analysis

This meta-analysis included a total number of 3377 patients with 1740 patients undergoing interbody fusion and 1637 patients undergoing PLF. The follow-up period was nearly similar between studies, ranging from one to two years post-operatively. The patient's age ranged from 50-85 years old.

VAS outcome

We performed a subgroup analysis to evaluate whether PLIF or lateral fusion had better significant outcome in pain aspect. VAS score was measured in 4 studies to evaluate pain of lumbar area post operatively. In these four studies, the VAS of 1569 patients treated PLIF and 1225 patients treated with lateral fusion were evaluated. There is no significant difference found between these two groups in VAS (mean difference 0.44; 95% CI, P = 0.58)

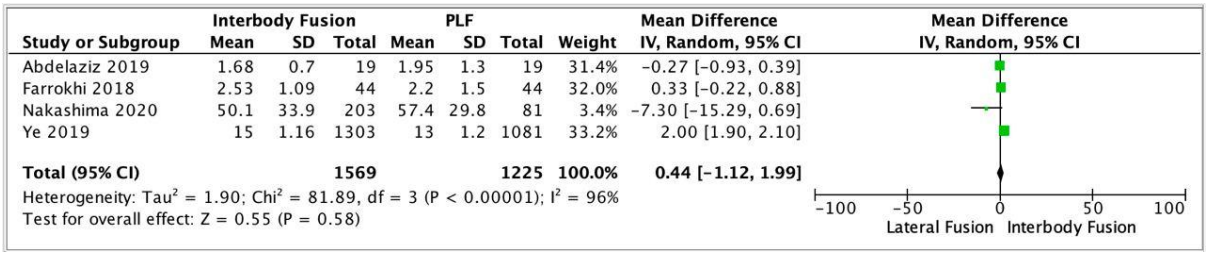

Figure 2 Forest plot analysis for VAS

ODI outcome

We performed a subgroup analysis to evaluate whether PLIF or lateral fusion had better outcome in activities of daily living. ODI score were measured in 2 studies to evaluate level of function in activities of daily living in those rehabilitating from low back pain. In these two studies, the ODI scoring evaluated 88 patients treated with PLIF and 72 patients with lateral fusion. There is also no significant difference found between these two groups in ODI (mean difference 1.49; 95% CI, P = 0.19).

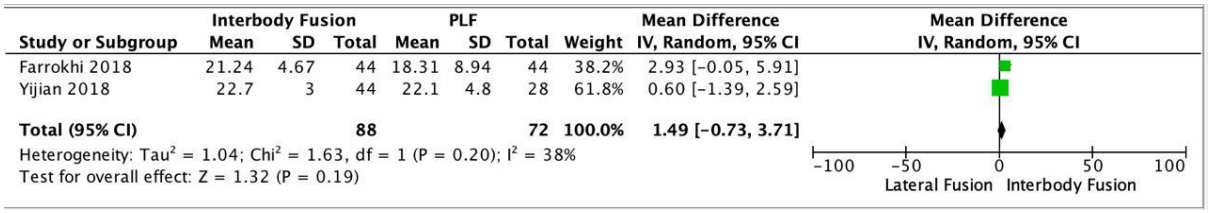

Figure 3 Forest plot analysis for ODI

DISCUSSION

Most degenerative spine diseases are managed conservatively unless there are acute neurological symptoms, progressive and disabling neurological deficits, or destabilization and abnormal spinal motion. Surgical intervention is crucial for patients with intolerable pain who do not respond to conservative treatment, as it helps alleviate pain and improve functional activity. These various conditions can be treated surgically, with spinal fusion being used to stabilize the spine. Interbody fusion implants are now commonly used to restore disc height and support the anterior column.[1]

In this study, we aim to evaluate and compare the traditional posterolateral lumbar fusion (PLF) with interbody fusion techniques, including posterior lumbar interbody fusion (PLIF) and lateral lumbar interbody fusion (LLIF), for treating degenerative lumbar diseases. While both interbody fusion and

lateral fusion are effective treatments for degenerative spine disease, the superior approach remains debated. Our primary outcomes of interest were the visual analog score (VAS) and the Oswestry Disability Index (ODI), both widely used to assess the functional status of patients with back pain, a common symptom of degenerative spine diseases. Meta-analyses of four studies found no significant difference between PLF and interbody fusion groups in postoperative VAS (mean difference 0.44; 95% CI, P = 0.58). Similarly, analysis of two studies revealed no significant difference in ODI between the two groups (mean difference 1.49; 95% CI, P = 0.19).

According to Yijian et al., both the interbody fusion and lateral fusion groups showed significant improvement in ODI outcomes from pre-operative to post-operative stages. However, no significant difference was observed between the two groups. In their study, two patients in the interbody fusion group and seven in the lateral fusion group reported chronic low back pain, which affected their functional activity. Ekman et al. compared the outcomes of interbody fusion and lateral fusion in adults with isthmic spondylolisthesis and found that the type of fusion did not affect pain levels two years after surgery. Similarly, Audat et al. compared the clinical outcomes of both techniques and concluded that both are equally suitable for treating degenerative disc disease, with no difference in VAS scores between the two methods.[11]

The results in our meta-analysis are somewhat contrast to study by Farrokhi *et al*. In their study, lateral fusion was proven to provide better clinical outcomes and improvement in the pain aspect, functional quality of life, and correction of Cobb angle.[6] Study by Abdelaziz et al showed., the average operative blood loss was 515 ml for interbody fusion and 457 ml for lateral fusion, indicating that blood loss in interbody fusion is slightly higher. This may be due to the longer duration and more extensive nature of the procedure. Farrokhi et al. also found that patients who underwent lateral fusion experienced less intraoperative blood loss compared to those who had interbody fusion. Extensive decompression and fusion can lead to significant complications, such as post-operative infections. However, Zhou et al. reported no significant differences in blood loss between interbody fusion and lateral fusion..[6]

In terms of radiographic outcomes, Nakashima et al. reported that the lateral fusion group achieved better local lordotic angle, disc height, and lumbar lordosis after fusion compared to the interbody fusion group. Lateral fusion has a greater potential for angle correction. Furthermore, Farrokhi et al. found that the mean Cobb angle correction rate after 12 and 24 months of follow-up was significantly higher in the lateral fusion group than in the interbody fusion group. Many studies have indicated that complications associated with the interbody fusion procedure include permanent neurological deficits, cerebrospinal fluid leakage, radicular pain, and deep wound infections. Our meta-analyses also found similar complications, albeit with a low complication rate.[6] (Table 3).

CONCLUSION

VAS and ODI outcomes were not significantly different between PLF and interbody fusion. However, PLF might provide better Cobb angle correction, meanwhile other outcome aspects were observed to be similar between the two groups. Surgeons need to consider other aspects when deciding on which procedure to perform, such as patient characteristics, surgeon’s preferences and the underlying degenerative spine disease itself. Further studies with larger population and better study design are necessary to provide more data on the outcomes of PLF and interbody fusion.

Declaration by Authors

Ethical Approval: Not Applicable

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Conflict of Interest: The authors declare no conflict of interest.

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