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Review article

A meta-analysis comparing ALIF, PLIF, TLIF and LLIF

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ABSTRACT

Introduction: Lumbar interbody fusions have been widely used to treat degenerative lumbar disease that fails to respond to conservative treatment. This procedure is divided according to its approach: anterior lumbar interbody fusion (ALIF), posterior lumbar interbody fusion (PLIF), transforaminal lumbar interbody fusion (TLIF) and lateral lumbar interbody fusion (LLIF). Each approach has its own theoretical advantages and disadvantages; however, there have been no studies that compared these.

Methods: Various full-text databases were systematically searched through December 2015. Data regarding the radiological, operative and clinical outcomes of each lumbar interbody fusion were extracted. All outcomes were pooled using random effects meta-analysis, with the relative risk (RR) and/or weighted mean difference (WMD) as the summary statistic.

Results: Thirty studies met the inclusion criteria. The ALIF procedure has been studied most intensively, followed by PLIF, TLIF and LLIF respectively. All four approaches had similar fusion rates ($p = 0.320$ & 0.703). ALIF has superior radiological outcome, achieving better postoperative disc height ($p = 0.002$ & 0.005) and postoperative segmental lordosis ($p = 0.013$ & 0.000). TLIF had better Oswestry Disability Index scores ($p = 0.025$ & 0.000) while PLIF had the greatest blood loss ($p = 0.032$ & 0.006). Complication rates were similar between approaches. Other comparisons were either inconclusive or lacked data. There was marked less studies comparing against LLIF.

Conclusions: Each approach has their own risks and benefits but similar fusion rates. Despite the large number of studies, there is little data overall when comparing specific aspects of lumbar interbody fusions. More studies, especially RCTs are needed to further explore this topic.

1. Introduction

Non-specific lower back pain caused by degenerative lumbar disease such as disc and facet joint degeneration or spondylolisthesis significantly impairs quality of life of patients, and is associated with higher pain scores and reduced function. Patients that fail to respond to conservative treatment may require surgical intervention, such as lumbar interbody fusion (LIF) [1]. This procedure is divided into several types depending on its approach, which are anterior lumbar interbody fusion (ALIF), posterior lumbar interbody fusion (PLIF), transforaminal lumbar interbody fusion (TLIF) and lateral lumbar interbody fusion (LLIF) [2]. These procedures involve a bone graft between the vertebrae to unite the bones of opposing vertebral endplates adjacent to the degenerative disc, and may also include other instrumentation, such as pedicle screws, plates or cages for structural integrity.

In US, the rates of spinal fusion procedures in patients with non-specific back pain are on the rise [3]. Each surgical approach has both benefits and limitations. For example, ALIF uses a retroperitoneal approach to expose the anterior spine, and is therefore associated with increased risk of direct vascular injury and ureteral injury [4,5]. However, by avoiding dissection of paraspinal muscles, ALIF patients have reduced postoperative pain and shorter inpatient stays [6–8] On the other hand, PLIF accesses disc space via a direct posterior approach through a midline incision. This is beneficial in avoiding approach-related vascular complications associated with ALIF, and it also allows for better surgical exposure for decompression of the neural elements [9]. The posterior approach is however associated with neurological complications due to risk of retraction on thecal sac and nerve roots, with reported rates of 9.0–24.6% postoperative neurological deficit [10].

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With regards to TLIF, its transforaminal approach avoids significant vascular complications, and has a lower rate of neurological complications when compared to PLIF. The disadvantages of TLIF are its extensive muscle retraction and dissection, which may lead to postoperative pain, delayed rehabilitation and impaired spinal function [11]. In contrast, LLIF takes on a lateral incision to access the retroperitoneal space to allow discectomy and end plate preparation. The trans-poas approach is beneficial in that it avoids manipulation of aorta or vena cava, avoids neurological injury as well as spares the paraspinal muscles [12]. Despite the benefits, LLIF involves the splitting of psoas muscle, which may incur damage to neural structures such as the lumbar plexus, causing lower limb weakness and paraesthesias [13,14].

Despite the knowledge about each individual approach, there have not been any studies that compared the outcomes of these four different approaches. Thus, this study aims to compare the radiological, operative and clinical outcomes of the ALIF, PLIF, TLIF and LLIF in treating degenerative lumbar spinal disease through a meta-analysis.

2. Methods

Recommended guidelines for systematic review and meta-analyses were followed [15].

2.1. Inclusion criteria

Studies that were included compared any two or more of ALIF, TLIF, LLIF and PLIF in any of these areas: radiological outcomes (e.g. fusion rates, post-operative disc height), clinical outcomes (e.g. Visual analog scale (VAS) & Oswestry disability index (ODI) scores), operative outcomes (e.g. blood loss, hospital stay) and complications.

2.2. Exclusion criteria

Studies that were excluded had any of the following features:

1. Subjects less than 18 years old – e.g. adolescent or child studies
2. Reviews, meta analysis or expert opinions
3. Patients with infection, tumour, or rheumatoid arthritis
4. Case reports & case control studies
5. No abstract
6. Studies where any of the procedures were combined with another (e.g. PLIF + PLF)

2.3. Search criteria

A systematic literature search was conducted in the following order: a title screen, an abstract screen and a full text screen. Five databases with access to full text collections were searched; Ovid MEDLINE, Ovid EMBASE, PubMed, Cochrane Register of Controlled Trials, and Web of Science from their date of inception to December 2015. The following search terms were used: (Anterior lumbar interbody fusion OR ALIF OR Posterior lumbar interbody fusion OR PLIF OR Transforaminal lumbar interbody fusion OR TLIF OR Lateral interbody fusion OR LLIF OR Lateral lumbar interbody fusion) AND (Outcome* OR Fusion rate* OR Success rate* OR Result*). Where possible, the search was limited to English studies and human subjects. References of key papers were also reviewed for potential studies for inclusion. Two independent full text screens were undertaken by two different researchers, and discrepancies in study selection were resolved by consensus. When institutions published duplicate studies with accumulating numbers of patients or increased lengths of follow-up, only the most complete reports were included.

2.3. Data extraction and critical appraisal

Data were extracted from the full text copy of the reports using a standardised proforma. Authors were contacted by email to clarify ambiguity or retrieve insufficient information. Data extracted included, study population, size, and age, operative details, operation indication, radiographic outcomes (fusion rates, post-operative disc height, post-operative lumbar lordosis, post-operative whole lumbar lordosis, post-operative spondylolisthesis), clinical outcomes (post-operative VAS and ODI scores), operative outcomes (operative duration, total blood loss, hospital stay), and complication rates (reoperation rates, dural injury, cage migration/malposition, pedicle malposition, other device related complication, neurological deficits, infections, blood vessel injury and venous thromboembolic events). When exact means and standard deviations (SD) were not reported, these values were estimated from available graphs.

The quality of all studies that were included in the study was analysed using the CEBM critical appraisal tool (1) (Appendix A).

2.5. Data analysis

All outcomes were pooled using random effects meta-analysis, with the relative risk (RR) and/or weighted mean difference (WMD) as the summary statistic. Random effects meta-analysis was used due to the assumption that the different studies are estimating different, yet related, intervention effects. I^2 statistic was used to estimate the percentage of total variation across studies owing to heterogeneity rather than chance. I^2 values of <25%, 25–50%, 50–75%, and >75% were considered to indicate no, low, moderate, and high heterogeneity, respectively. All p-values were 2-sided. Publication bias was investigated using funnel plots on outcomes with large numbers of data points. All data processing and statistical analyses were done using STATA version 13, utilising the user written commands – metan, and metafunnel (2,3).

3. Results

3.1. Literature search

The electronic searches identified 6114 articles, of which 40 full texts were assessed for eligibility. Thirty studies met the criteria for inclusion in the meta-analysis (Fig. 1). Table 1 shows the main characteristics of included studies. There were 5 studies that compared ALIF with PLIF, 7 studies that compared PLIF with TLIF, 9 studies that compared ALIF with TLIF, 3 that compared ALIF with LLIF, 3 that compared TLIF with LLIF, 1 that compared PLIF with LLIF, 1 that compared ALIF, PLIF and TLIF, and 1 that compared ALIF, LLIF and TLIF. In total, 14542 participants were included in this study. ALIF vs PLIF, ALIF vs TLIF, ALIF vs LLIF, PLIF vs TLIF and TLIF vs LLIF had a total of 11,342, 1281, 682, 781, 729 participants. PLIF vs LLIF had only one study and was removed from meta-analysis. Thirteen of the included studies were prospective cohort studies while the other seventeen were retrospective cohort studies.

All the included articles were of moderate to high quality (Appendix A).

Bias was assessed using funnel plots on overall complication rates for all comparisons as nearly all studies reported this. There was no evidence of publication bias (Appendix B).