

Review article

Does restoration of focal lumbar lordosis for single level degenerative spondylolisthesis result in better patient-reported clinical outcomes? A systematic literature review



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ABSTRACT

It is controversial whether the surgical restoration of sagittal balance and spinopelvic angulation in a single level lumbar degenerative spondylolisthesis results in clinical improvements. The purpose of this study to systematically review the available literature to determine whether the surgical correction of malalignment in lumbar degenerative spondylolisthesis correlates with improvements in patient-reported clinical outcomes. Literature searches were performed via Ovid Medline, Embase, CENTRAL and Web of Science using search terms “lumbar,” “degenerative/spondylolisthesis” and “surgery/surgical/surgeries/fusion”. This resulted in 844 articles and after reviewing the abstracts and full-texts, 13 articles were included for summary and final analysis. There were two Level II articles, four Level III articles and five Level IV articles. Most commonly used patient-reported outcome measures (PROMs) were Oswestry disability index (ODI) and visual analogue scale (VAS). Four articles were included for the final statistical analysis. There was no statistically significant difference between the patient groups who achieved successful surgical correction of malalignment and those who did not for either ODI (mean difference -0.94 , CI $-8.89-7.00$) or VAS (mean difference 1.57 , CI $-3.16-6.30$). Two studies assessed the efficacy of manual reduction of lumbar degenerative spondylolisthesis and their clinical outcomes after the operation, and there was no statistically significant improvement. Overall, the restoration of focal lumbar lordosis and restoration of sagittal balance for single-level lumbar degenerative spondylolisthesis does not seem to yield clinical improvements but well-powered studies on this specific topic is lacking in the current literature. Future well-powered studies are needed for a more definitive conclusion.

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1. Background

Lumbar degenerative spondylolisthesis is a common spinal degenerative condition that largely affects individuals at the age of 50 or older [1]. It can cause severe lower back pain and/or lower extremity pain [2]. There are many surgical treatment options including posterior/transforaminal lumbar interbody fusion (PLIF and TLIF). Both of these procedures have increased in popularity over the past decade and have been shown to improve patient-reported quality of life significantly [3].

Few studies have evaluated the impact of creating or restoring focal lordosis with interbody fusion surgery [4]. With more surgeons using interbody devices due to improved fusion rates, further research is needed to evaluate the magnitude of focal

lordosis that can be achieved with single level interbody fusions. Further, it is critical to determine whether this will have any impact on patient-reported quality of life outcomes [5].

Surgical restoration of sagittal balance and spinopelvic angulation has been shown to improve patient-reported outcomes in spinal fusions involving multiple levels [6,7]. The optimal treatment for degenerative spondylolisthesis, however, remains controversial. Although PLIF has not been shown to result in superior clinical outcomes compared to the instrumented posterolateral fusion (PLF), some argue that PLIF results in improvement in certain radiographic parameters such as the slip angle and the degree of spondylolisthesis [8,9]. It is unclear, however, whether this radiographic improvement correlates with better long-term clinical outcomes to warrant the addition of an interbody cage, which comes with additional cost and potential complications [10].

The purpose of the current paper is to systematically assess the available literature and determine whether there is a correlation

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between surgical correction of lumbar lordosis and pelvic parameters in single-level degenerative spondylolisthesis and the patient-reported clinical outcomes. The impact of lumbar lordosis on sagittal alignment is systematically reviewed within these articles.

2. Methods

2.1. Search strategy

The systematic review searches were created by a medical librarian (S.V.) in collaboration with the research team (C.R., R.A.G.). The search was created in Ovid Medline using a combination of key terms and index headings related to spondylolisthesis, the lumbar region, lordosis and spine surgery, then translated into subsequent bibliographic databases once finalized (see [Appendix](#) for full Medline search).

The searches were conducted August 1, 2016 in Ovid Medline (In-Process & Other Non-Indexed citations and Ovid Medline(R) 1946-August 1, 2016), Embase (Elsevier) (1974-August 1, 2016), CENTRAL (Wiley) (Issue 7 of 12 July 2016), and Web of Science (Thomson Reuters) (1900-August 1, 2016). Search results were exported into EndNote X7 and duplicates were removed using the program's duplicate identification function, as well as through a manual scan of the references.

2.2. Study selection

The inclusion criteria were as follows:

- (1) adult patients (18 years of age or older) who underwent posterolateral fusion in addition to interbody implants for the diagnosis of a single level lumbar degenerative spondylolisthesis;
- (2) measurement of preoperative and postoperative patient-reported clinical outcomes;
- (3) measurement of preoperative and postoperative radiographic outcomes including sagittal balance and pelvic parameters; and
- (4) statistical analysis to evaluate the correlation between the correction of radiographic parameters and PROMs.

The exclusion criteria were as follows:

- (1) isthmic or congenital spondylolisthesis;
- (2) interbody implants inserted via anterior or lateral approach;
- (3) more than 2 level surgery; and
- (4) previous spine surgery at operative or adjacent level.

Two authors (C.R. and R.A.G.) independently reviewed the titles and the abstracts of the articles. When there was a disagreement about the eligibility of the articles between the authors, the articles were included for full-text review. The data extraction sheet was generated with the involvement of all the authors and used to extract the following data from each article: (1) study design; (2) study population and duration of follow-up; (3) radiographic measurements; (4) patient-reported clinical outcomes; and (5) any potential conflict of interests and risk of bias. The level of evidence was assigned to each article based on the criteria described by Wright and colleagues, as shown in [Table 1](#) [11].

When possible, the study population in each article reviewed was broadly categorized to balanced and unbalanced groups based on spinopelvic parameters. The intimate relationships between the pelvic parameters and lumbar lordosis were shown in the literature [12,13]. Generally, about 5–6 degrees of focal lordosis can be achieved through intraoperative reduction [14,15]. In addition,

Table 1
Levels of evidence for therapeutic studies [11].

Levels of evidence for therapeutic studies	
Level I	Randomised controlled trial with significant difference, or no significant difference but narrow confidence interval; systematic review of Level-I studies
Level II	Prospective cohort study; poor-quality randomized controlled trial; systematic review of Level I-II studies
Level III	Case-control study; retrospective cohort study; systematic review of Level I-III studies
Level IV	Case series
Level V	Expert opinion

pelvic incidence-lumbar lordosis mismatch is associated with development of adjacent segment disease, where the mismatch is defined as a difference between pelvic incidence and lumbar lordosis (PI-LL) of 10 or greater [16]. Based on these parameters, the balanced group was defined as focal lordosis correction of 4 degrees or more, and/or pelvic incidence-lumbar lordosis difference of less than 10 degrees. In cases where the data presented in the articles are insufficient to perform statistical analysis, the corresponding authors were contacted in attempt to obtain the raw data. The comparison between the balanced and the unbalanced groups were made based on PROMs.

3. Results

The combined bibliographic database searches using the four aforementioned search engines generated 1171 articles. After duplicates were removed, 844 articles were reviewed for inclusion. Following the independent review by the two authors (C.R. and R.A.G.) according to the pre-determined inclusion and exclusion

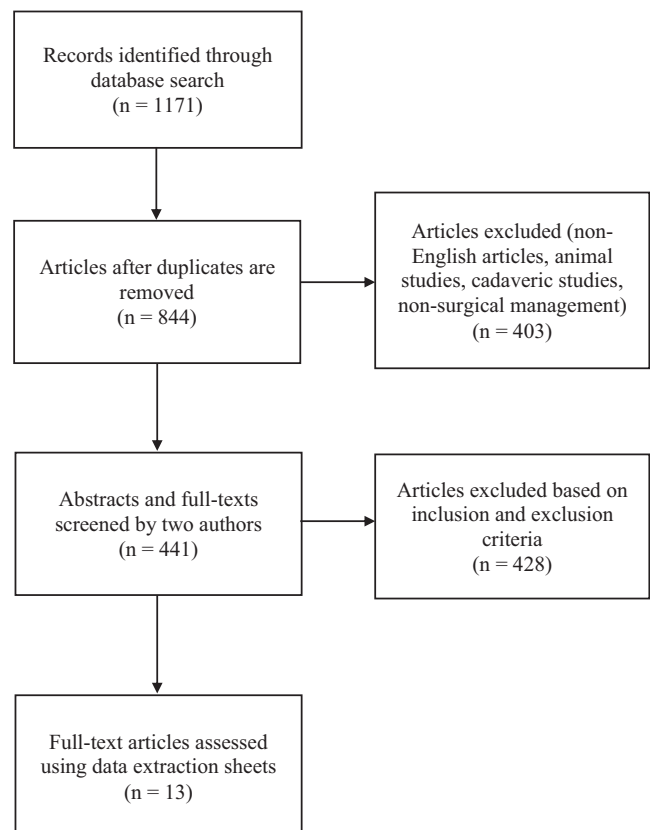


Fig. 1. A flow chart summarizing the study selection based on PRISMA (Preferred Reporting Items for Systemic Reviews and meta-analyses) guideline [35].

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