Comparison of unilateral versus bilateral pedicle screw fixation in lumbar interbody fusion: a meta-analysis

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Abstract

Purpose This is a meta-analysis to compare the clinical results between unilateral and bilateral pedicle screw (PS) fixation in lumbar interbody fusion.

Methods We included published studies with no language and year restrictions. The criteria which Koes et al. designed in 1995 were used to evaluate the risk of bias of the included studies. All data were analyzed by Review Manager 5.1. The primary outcomes included fusion rate and screw complications, and the secondary outcomes were operative time, blood loss, and hospital time.

Results A total of five prospective studies with 407 patients were included in the current meta-analysis, and four of them were randomized controlled trials. There was no significant difference between unilateral PS fixation and bilateral PS fixation group in fusion rate and screw complications (fusion rate: OR 0.54, $Z = 1.33$, $P = 0.18$, $I^2 = 0\%$; screw complications: OR 1.45, $Z = 0.71$, $P = 0.48$; $I^2 = 44\%$). In the secondary outcomes, the operative time ($Z = 3.35$, $P = 0.0008$; $I^2 = 95\%$) and blood loss ($Z = 4.35$, $P < 0.0001$; $I^2 = 98\%$) was significantly higher in bilateral PS fixation group than in unilateral PS fixation group. Besides, no significant

difference was found in hospital time ($Z = 1.19$, $P = 0.24$; $I^2 = 99\%$).

Conclusions In our meta-analysis, we found that unilateral PS fixation in lumbar fusion was as effective as bilateral PS fixation for lumbar degenerative diseases without major instability, no significant difference was found in hospital time, fusion rate and screw complications. In terms of operative time and blood loss, unilateral PS fixation even produced better results.

Keywords Unilateral pedicle screw · Bilateral pedicle screw · Lumbar vertebra · Spinal fusion · Meta-analysis

Introduction

Lumbar fusion is one widely used method for surgical treatment of lumbar degenerative diseases, such as lumbar spinal canal stenosis, spondylolytic spondylolisthesis, and degenerative spondylolisthesis. It is generally accepted that pedicle screw (PS) fixation is necessary to achieve a stable fixation result. This kind of fixation is effective in improving bone fusion rate and correcting lumbar alignment [1].

Bilateral PS fixation is a traditionally accepted method used in lumbar interbody fusion. This method provides both biomechanical and clinical advantages [2]. However, due to the excessive rigidity of the system, internal fixation has caused the reduction of bone mineral content [3] and degeneration of adjacent segments [1]. This led to the use of unilateral PS fixation aiming to decrease the rigidity of internal fixation. From the publication of the work by Kabins et al. [4], who performed lumbar fusion using unilateral PS fixation and reported favorable results in

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1992, the clinical application of unilateral or bilateral PS turns into a controversial issue.

Herein, we performed a meta-analysis of the available literature to better understand the effectiveness of unilateral PS fixation in clinical outcome and rate of fusion in comparison with the bilateral PS fixation. These data provide important insights capable of better informing clinical surgeons regarding the use of PS fixation and management of lumbar degenerative diseases.

Materials and methods

Study design, search strategy, and study selection

Before data collection, two groups were supposed to be compared: unilateral PS fixation group and bilateral PS fixation group. The relevant publications were searched from electronic databases of PubMed, EMBASE, and Web of Science. We also used Google Scholar as a supplement. In order to limit publication bias, we included published trials with no language and year restrictions. ‘Spinal fusion’, ‘unilateral’, ‘bilateral’ and ‘pedicle screw’ were used as search terms. In addition, we examined the references of previously published reviews to identify additional relevant studies.

The inclusion criteria for our analysis included studies with the following characteristics: (1) Human subjects; (2) prospective study (randomized controlled trial (RCT) is preferred); (3) patients were diagnosed with lumbar degenerative diseases according to symptoms, signs and imaging data; (4) comparative data between bilateral and unilateral group were provided. Studies were excluded according to the following criteria: (1) studies only involving pediatric patients; (2) letters, case reports, editorials or reviews. Two reviewers independently screened the abstracts of all eligible studies. If the study was indeterminable from the abstract, the paper was included in the full-text screen. The same two reviewers then screened the articles at the full-text level. All disagreements were adjudicated by the principal investigator.

Quality assessment, data extraction, and outcome measures

Two reviewers independently rated study quality using the Agency for Healthcare Research and Quality (AHRQ) quality criteria for the assessment of studies. These criteria contained 16 questions and were from the study which Koes et al. [5] reported in 1995. The full score was 100 points, and the study which got more than 60 points was considered as a great study with high quality. Disagreements were resolved by consultation with a third reviewer.

For the trials included in our meta-analysis, we sought data for demography information, operative time, blood loss, hospital time, fusion rate, screw complications for all patients. The primary outcomes of our meta-analysis were fusion rate and screw complications, and the secondary outcomes were operative time, blood loss and hospital time. Fusion was established by the X-ray films and computed tomography at the end of the follow-up period. The screw complications included screw malposition, screw loosening, and screw breakage. The data were extracted by two investigators independently. The conducts and reports were in accordance with the quality of reporting of meta-analyses statement.

Statistical analysis

For each outcome, we used the statistical software Review Manager 5.1 (The Cochrane Collaboration, Oxford, UK) to analyze the collected data and to compare unilateral PS fixation group with bilateral PS fixation group. The primary outcomes (fusion rate and screw complications) and the secondary outcomes (operative time, blood loss, hospital time) were analyzed as continuous or dichotomized variables using random effect model or fixed effect model, and their results were reported as mean difference (95 % confidence interval) or odds ratio (95 % confidence interval), respectively. The statistic strength was measured by overall effect size Z and heterogeneity index I^2 .

Results

Study inclusion and characteristics of included studies

The search strategy generated 925 references from PubMed, EMBASE, and Web of Science. This also included reviews and articles that were duplicated or did not meet our inclusion criteria. Figure 1 shows the flow diagram of study identification. After careful full-text evaluation, we included a total of five prospective studies with 407 patients in the current meta-analysis [6–10]. The details of demographic and clinical characteristics of patients are shown in Tables 1 and 2, and no significant differences were found in baseline characteristics between the two groups. The mean duration of follow-up was more than 2 years, the mean age of patients was between 53 and 67, and the number of patients in five studies varied from 50 to 108. All studies were prospective controlled studies and four of them were RCTs. There was the fact of bone transplant in all of the five studies, and cage was additionally used in two of them. Other three studies mentioned that they used posterolateral bone transplant.

Fig. 1 Flow diagram of study identification

Methodological quality

The scores of studies assessed by AHRQ quality criteria ranged from 59 to 71. And the result was presented in Table 3. Two reviewers assessed the methodological quality of the included studies independently. They reached consensus on the scoring of all items without any disagreement. Three included studies got 63 points, while other two studies got 71 points and 59 points respectively. The items where all of the included studies lost points were item F, J, K and M. To some extent, this was due to the small sample size and non-blinded study. In general, the methodological quality of the included studies was not bad.

Fusion rate

The fusion rate data was available in all five studies, and no nonunion case was reported in the study of Xie [10]. No evidence of statistical heterogeneity was found between the two groups ($P = 0.90$, $I^2 = 0\%$). And we chose the fixed effects model for analysis. There was no significant

difference between unilateral PS fixation group and bilateral PS fixation group in total analysis (OR 0.54, $Z = 1.33$, $P = 0.18$) (shown in Fig. 2a).

Screw complications

For the meta-analysis of unilateral PS fixation versus bilateral PS fixation group in screw complications at the end of the follow-up, there was no significant difference between unilateral PS fixation group and bilateral PS fixation group in total (OR 1.45, $Z = 0.71$, $P = 0.48$; $I^2 = 44\%$). The incidence of unilateral PS fixation and bilateral PS fixation group was 4.4 and 3 % respectively (shown in Fig. 2b). For details, please see Table 4.

Operative time

The operative time data was available in four studies [6–9], which was shown in Fig. 3. Because of the lack of standard deviations data in two studies [6, 7], we obtained standard deviations from standard errors, t values and P values for differences in means, with the use of formula from Cochrane Handbook for Systematic Reviews of Interventions. Xie et al. [10] did not provide the exact P values, so we had to give up these data. Xue et al. [9] reported the comparison in subgroup of one level or two level fusion, we took each one as the independent object of analysis. So did the management of following blood loss and hospital time. The forest plot graph of the comparison showed that in total, the operative time was significantly higher in bilateral PS fixation group than in unilateral PS fixation group ($Z = 3.35$, $P = 0.0008$; $I^2 = 95\%$, random effects model).

Blood loss

Then, we conducted a meta-analysis of blood loss of patients receiving unilateral PS fixation versus bilateral PS fixation, which was shown in Fig. 3. The forest plot graph of the comparison showed that, the blood loss of patients was significantly lower in unilateral PS fixation group than

Table 1 Basic characteristics of the studies included in this meta-analysis

Author	Year	Country	Study design	Sample size (unilateral/bilateral)	Mean age (unilateral/bilateral)	Gender (M/F)	Duration of follow up (months)
Xie et al. [10]	2012	China	Randomized controlled trial	108 (56/52)	56.2/55	48/60	More than 36
Aoki et al. [6]	2012	Japan	Randomized controlled trial	50 (25/25)	66.2/65.6	20/30	More than 24
Xue et al. [9]	2012	China	Randomized controlled trial	80 (37/43)	57.1/58.2	35/45	Mean 25.3
Fernandez-Fairen et al. [8]	2007	Spain	Randomized controlled trial	82 (40/42)	60.8/61.4	31/51	36
Suk et al. [7]	2000	Korea	Randomized controlled trial	87 (47/40)	53.0/54.7	22/65	More than 24

Table 2 The including diseases, outcomes, and fusion definition of the included studies

Study	The included diseases	Outcome measures			The definition of fusion
		Primary outcomes	Secondary outcomes	Other outcomes	
Xie et al. [10]	Recurrent lumbar disk herniation, symptomatic lumbar stenosis with segmental instability, or symptomatic degenerative disk disease	Fusion rate; screw complications	Operative time; blood loss; hospital time	JOA scores; SF-36 scores	Radiographic evidence existed of bone bridging the disk space without lucency and the motion between the fused segments was <4° on flexion and extension views
Aoki et al. [6]	Grades 1 and 2 degenerative spondylolisthesis	Fusion rate; screw complications	Operative time; blood loss	VAS score; postoperative JOABPEQ scores	The presence of continuous trabecular bone formation through or outside the cages, <3° movement on lateral flexion and extension radiographs, and the absence of radiolucent lines around >50 % of the implant
Xue et al. [9]	Spinal stenosis with spondylolisthesis, low-grade degenerative spondylolisthesis without significant stenosis, huge lumbar disc herniation, discogenic low back pain, ultralateral disc herniation and recurrent lumbar disc herniation	Fusion rate; screw complications	Operative time; blood loss; hospital time	Postoperative VAS; mProlo; ODI scores	Continuous osseous trabecular bridging the graft-transverse interface or stable fusion of the segment with standards <4 mm of translation or <10° of angular motion between adjacent end plates on lateral flexion-extension radiographs
Fernandez-Fairen et al. [8]	Degenerative spondylolisthesis	Fusion rate; screw complications	Operative time; blood loss; hospital time	SF-36v2; loss of height of adjacent discs	Continuity was appreciated in the fusion mass between the cephalad and caudal transverse processes, with trabeculae crossing the graft-transverse interface on both sides, with <4° of motion and no translation between the vertebrae
Suk et al. [7]	Spinal stenosis, spondylolytic spondylolisthesis, and degenerative spondylolisthesis	Fusion rate; screw complications	Operative time; blood loss; hospital time	Satisfactory clinical outcome; Medical expenses paid by patients	Less than 4° of motion between the fusion segments on flexion and extension view and the presence of a contiguous, mature trabecular graft were required for an attempted fusion to be considered solid or healed

Table 3 Study quality characteristics

Criterion	Weight	Xie et al. [10]	Aoki et al. [6]	Xue et al. [9]	Fernandez-Fairen et al. [8]	Suk et al. [7]
A	2	2	2	2	2	2
B	5	5	5	5	5	5
C	4	4	4	4	4	0
D	3	3	3	3	3	3
E ^a	2	2	2	2	2	2
E ^b	2	2	2	2	2	2
F ^a	8	8	0	0	0	0
F ^b	9	0	0	0	0	0
G	10	10	10	10	10	10
H	5	5	5	5	5	5
I	5	5	5	5	5	5
J	5	0	0	0	0	0
K	5	0	0	0	0	0
L	10	10	10	10	10	10
M	10	0	0	0	0	0
N	5	5	5	5	5	5
O	5	5	5	5	5	5
P	5	5	5	5	5	5
Total score	100	71	63	63	63	59

A, Homogeneity; B, Comparability of relevant baseline characteristics; C, Randomization procedure adequate; D Drop-outs described for each study group separately; E^a <20 % loss to follow-up, E^b < 10 % loss to follow-up; F^a > 50 subjects in the smallest group, F^b > 100 subjects in the smallest group; G Interventions included in protocol and described; H Pragmatic study; I Co-interventions avoided; J Placebo-controlled; K Patients blinded; L Outcome measures relevant; M Blinded outcome assessments; N Follow-up period adequate; O Intention-to-treat analysis; P Frequencies of most important outcomes presented for each treatment group

in bilateral PS fixation group ($Z = 4.35$, $P < 0.0001$; $I^2 = 98$ %, random effects model).

Hospital time

Finally, we conducted a meta-analysis of hospital time of patients receiving unilateral PS fixation versus bilateral PS fixation, which was shown in Fig. 3. The forest plot graph of the comparison showed that, there was no significant difference between unilateral PS fixation group and bilateral PS fixation group in hospital time ($Z = 1.19$, $P = 0.24$; $I^2 = 99$ %, random effects model).

Other results

In the report of Xie et al., the results of JOA scores were consistent with SF-36 scores. A significant difference existed when comparing pre-operative and post-operative

scores in both two groups, but no significant difference existed when comparing scores between these two groups at each point. Xue et al., reported that, the implant cost was significantly lower in unilateral PS fixation group than in bilateral PS fixation group. Both groups got the significantly improved postoperative visual analog scale (VAS), modified Prolo (mProlo) scores, and Oswestry disability index (ODI), but no significant difference between groups was found. In the included study of Fernández-Fairen et al., there was no significant difference between the two groups in relation to clinical results. Suk et al., also reported lower medical expense and similar clinically satisfactory result in unilateral PS fixation group. According to statistics, the medical expenses paid by each patient reduced 20 % in unilateral PS fixation group. Aoki et al., showed the different results that bilateral PS fixation group gained significantly better improvement than unilateral PS fixation in VAS score for lower-extremity pain and numbness. But there was no significant difference between the groups in evaluation of postoperative disability with Japanese Orthopaedic Association Back Pain Evaluation Questionnaire (JOABPEQ) (See Table 5).

In consideration of there was only one non RCT in our analysis, we made analysis which excluding the study of Suk et al., and we got the similar results (fusion rate: $P = 0.39$; $I^2 = 0$ %; screw complications: $P = 0.83$; $I^2 = 66$ %; operative time: $P = 0.0002$; $I^2 = 95$ %; blood loss: $P < 0.0001$; $I^2 = 98$ %; hospital time: $P = 0.31$; $I^2 = 100$ %) (See Supplemental Figures 1 and 2).

Discussion

When treating the lumbar degenerative diseases, addition of bilateral PS system has been widely used to achieve rigid internal fixation. However, due to the excessive rigidity of the system, internal fixation has caused the reduction of bone mineral content [3] and degeneration of adjacent segments [1]. Some scholars have been trying to solve this problem by investigation of impact factors and the development of orthopaedic technologies. Chen et al. [11] reported that meticulous surgical dissection without injuring the adjacent facet joints, proper pedicle screws instrumentation with the appropriate entry trajectory, and use of top-loading screw heads are some ways which could decrease the risk of adjacent facet joint violation.

To our knowledge, the clinical application of unilateral or bilateral PS fixation is a controversial issue. Most of the articles published were to make the biomechanics comparison of these two methods in vitro. Goel et al. [12] demonstrated that unilateral PS fixation did reduce stress shielding on the fixed vertebrae, and diminish peak stress rising in the adjacent levels above and below the fusion.

Fig. 2 Meta-analysis of unilateral PS fixation group versus bilateral PS fixation group in fusion rate and screw complications. **a** The comparison in fusion rate, **b** The comparison in screw complications. There was no significant difference between unilateral PS fixation and bilateral PS fixation group in total analysis. Z total effect size, I^2

heterogeneity index. Columns in blue represent the odds ratio of each study and column size represent the study weight in the analysis. Lanes represent the 95 % CI of each study. Diamonds in black represent the overall effect size and diamond width represent the overall 95 % CI

Table 4 Screw complications of these two groups

Study	Unilateral pedicle screw fixation	Bilateral pedicle screw fixation
Xie et al. [10]	0/56	0/52
Aoki et al. [6]	0/24	0/23
Xue et al. [9]	3/37 (malposition 1; looseness 2)	1/43 (looseness 1)
Fernandez-Fairen et al. [8]	0/40	3/42 (malposition 3)
Suk et al. [7]	6/47 (not mentioned)	2/40 (not mentioned)

Chen et al. [13] reported that unilateral fixation was a good alternative to spinal fusion considering the initial stability and the load-sharing effect. Some authors did not support the use of unilateral PS fixation. Kasai et al. [14] reported that unilateral PS fixation provided uneven fixation while the bilateral fixation achieved excellent fixation in all directions. Yucesoy et al. [15] reported that unilateral PS fixation was inadequate for stabilizing a 2-level unilateral lesion when compared with bilateral fixation. Kaibara et al. [16] considered that unilateral PS fixation plus interspinous anchor might offer an alternative to bilateral PS fixation. An increasing number of studies [17, 18] have recommended unilateral PS fixation plus contralateral translaminar facet screw which was comparable to bilateral PS fixation. This technology was also recommended by Sethi et al. [19] in the research with clinical and radiographic evaluation.

Besides, there were a number of studies whose results indicated that the use of unilateral PS fixation provides

excellent clinical results [20–22]. Unfortunately, these studies did not have the bilateral PS fixation group to be compared as the control group. Fusion rate and clinical efficiency were two main indexes to evaluate the effectiveness of fusion. In one retrospective review of Zhao et al. [23], unilateral PS fixation procedure could achieve great fusion rate, reduce the excessive rigidity of traditional bilateral fixation, and lessen the occurrence of adjacent level degeneration. On the other hand, Aoki et al. [24] followed 125 individuals who accepted the treatments of unilateral or bilateral PS system, this group advised that spine surgeons should consider the potential for postoperative cage migration and limitations of unilateral fixation. To the indication of these two procedures, Deutsch et al. [22] and Beringer et al. [20] showed that the use of unilateral PS fixation was an option in selected patients.

In our meta-analysis, we pooled data from 407 patients in five available published studies aiming to figure out whether the use of unilateral PS fixation can do better than bilateral PS fixation. According to the criteria which Koes et al. designed in 1995, the methodological quality of the included studies was not bad. We achieved a relatively low operative time and blood loss in unilateral PS fixation group. There was no significant difference between two groups in hospital time. All of these three indexes might be related with the medical system and proficiency of the surgeons. By contrast, the indexes of fusion and screw complication rate were more objective. And there was no significant difference in these, suggesting that the effectiveness of unilateral PS fixation procedure might be

Fig. 3 Meta-analysis of unilateral PS fixation group versus bilateral PS fixation group inoperative time, blood loss and hospital time. Xue et al. [10] represents the study of the single level fusion cases in the whole study by Xue et al. [10], while Xue et al. [10] represents the study of the double level fusion cases in the whole study by Xue et al. [9]. **a** The comparison in operative time, the operative time was significantly higher in bilateral PS fixation group than in unilateral PS fixation group. **b** The comparison in blood loss, the blood loss of patients was significantly lower in unilateral PS fixation group than in

bilateral PS fixation group. And **c** The comparison in hospital time, there was no significant difference between unilateral PS fixation group and bilateral PS fixation group in hospital time. Z total effect size, I^2 heterogeneity index. Columns in green represent the mean difference of each study and column size represent the study weight in the analysis. Lines represent the 95 % CI of each study. Diamonds in black represent the overall effect size and diamond width represent the overall 95 % CI

similar to bilateral PS fixation procedure. In theory, the screw complications in the unilateral fixation group would be 50 % fewer than those in the bilateral group. One reason for no significant difference was that the total numbers of screw complications were tiny the other reason, which was also discussed in the study of Suk et al., was that most of the screw complications in the unilateral fixation group occurred in the cases of spondylolytic spondylolisthesis.

And so far there were a few prospective comparative studies of unilateral and bilateral PS fixation in clinic. Limited to the amount of included studies, we could not obtain adequate data to be pooled to analyze the subgroup of single level or double level fusion. Xue et al. used VAS, mProlo, and ODI to analyze postsurgical pain and functional results, while Fernández-Fairen et al., and Xie et al., used SF-36 scores. Aoki et al., reported the results using JOABPEQ and VAS. And clinical outcomes were assessed by only the Kim and Kim method [25] in another included study. Although there was significantly less improvement in unilateral PS fixation group in VAS for lower-extremity pain and numbness, two groups both achieved effective

improvements in VAS after the operation. All of other results showed that there was no significant difference in clinical outcomes. Due to using the different evaluating methods, it is difficult to pool these data. We had no choice but to abandon these. Some studies showed the medical expenses reduced significantly in unilateral PS fixation group. Obviously, the main reason was the use of implant in only one side. It directly resulted in the fall of implant costs. We believe, in the context of similar clinical results, the unilateral PS fixation might be preferred by surgeons and patients due to lower medical costs. In view of the criteria for inclusion in these five studies, we must pay attention to the surgical indications. In our opinion, unilateral PS fixation in lumbar fusion might be as effective as bilateral PS fixation for lumbar degenerative diseases without major instability.

Our study has several important limitations. As for the adjacent segment degeneration after the fusion, only one of the five included studies reported this related issue. Fernández-Fairen et al., used the height of superior disc adjacent to the fusion to evaluate the adjacent segment

Table 5 The other outcomes in all of the included studies

Study	The result of no significant difference between groups (unilateral pedicle screw fixation vs. bilateral pedicle screw fixation)	The result of significant difference between groups (unilateral pedicle screw fixation vs. bilateral pedicle screw fixation)
Xie et al. [10]	JOA scores 1. Preoperation: 14.5 ± 3.2 vs. 15.1 ± 2.9 2. 3 year postoperatively: 26.1 ± 1.9 vs. 25.2 ± 3.2 SF 36 scores $p > 0.05$ in SF-36 subscale (8 items) scores between the 2 groups	None
Aoki et al. [6]	Postoperative improvement of VAS score for lower-back pain 1.5 ± 4.2 vs. 3.7 ± 3.2 ($p = 0.058$) JOABPEQ No significant intergroup differences in pain-related disorders, lumbar spine function, gait disturbance, social life disturbance, and psychological disorders	Postoperative improvement of VAS score for lower-extremity pain 2.1 ± 3.6 vs. 5.1 ± 3.2 ($p = 0.006$) Postoperative improvement of VAS score for lower-extremity numbness 1.7 ± 4.3 vs. 4.4 ± 3.1 ($p = 0.019$)
Xue et al. [9]	VAS 1. Preoperation: 8.2 ± 0.7 vs. 8.5 ± 0.4 2. 18 months postoperatively: 2.1 ± 0.8 vs. 2.1 ± 0.3 ODI 1. Preoperation: 43.4 ± 2.0 vs. 45.1 ± 2.6 2. 18 months postoperatively: 15.4 ± 1.7 vs. 15.8 ± 0.9 mProlo 1. Preoperation: 8.1 ± 2.1 vs. 8.5 ± 1.2 2. 18 months postoperatively: 17.5 ± 2.2 vs. 17.4 ± 2.5	None
Fernandez-Fairen et al. [8]	SF 36v2 scores $p > 0.05$ in SF-36v2 subscale (10 items) scores between the 2 groups Height of adjacent disc 1. Preoperation: 11.1 ± 2.52 vs. 10.91 ± 2.89 2. 3 years postoperatively: 10.84 ± 3.15 vs. 10.3 ± 2.69	None
Suk et al. [7]	Satisfactory clinical outcome 83.3 vs. 82.5 % ($p = 0.967$)	Medical expenses paid by patients 4130.0 vs. 5162.6 dollars ($p = 0.032$)

degeneration. And there was no significant difference between these two groups. In theory, once the fusion had been completed, the amount of pedicle screws did not play a key role, the risk of adjacent segment degeneration should be same in these two groups. The sample size in the study of Fernandez-Fairen et al., was relatively small, which may limit the outcomes, further randomized controlled trials with more patients should be performed.

Furthermore, previous studies reported that weight issues affected the prognosis of lumbar fusion surgery. Some researchers confirmed perioperative complications were more common in obese patients, but obese patients achieved similar benefits to non-obese patients [26]. Tuttle et al. [21] described the surgical treatment of unilateral fixation in patients who were obese, overweight, or normal weight, which yielded successful outcomes. Obese patients with appropriate indications for lumbar fusion surgery should not be denied unilateral PS fixation because of their

weight. Weight may be one of the factors which influence the biomechanics of the unilateral or bilateral PS fixation. But there is no evidence of evidence-based medicine to support that unilateral fixation is sufficient in light weight people but not in heavy weight ones. It needs further related studies to prove this.

Conclusions

This meta-analysis includes all current relevant studies from various countries covering different populations. It makes up for the shortage of small sample size and limited population of individual studies. This meta-analysis provides more powerful evidence on the clinical application of unilateral PS fixation in lumbar fusion. And it could be that unilateral PS fixation in lumbar fusion is as effective as bilateral PS fixation for lumbar degenerative diseases

without major instability. In terms of operative time and blood loss, unilateral PS fixation even produces better results. This finding needs further confirmed by larger RCT with long-term follow up.

Conflict of interest None.

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