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Minimally Invasive versus Conventional Transforaminal Lumbar Interbody Fusion in Treatment of Single-Level Low-Grade Lumbar Spondylolisthesis: A Systematic Review and Meta-Analysis

Mohamed Hassan Mahmoud[1], MD., Mohamed Shamia[1], MD., Mostafa Kofi[2], MD., Ali Abou-Madawi[1], MD.

[1]Neurosurgery Department, Faculty of Medicine, Suez Canal University, Ismailia, Egypt.
[2]Family Medicine Department, Prince Sultan Military Medical City, Riyadh, Saudi Arabia.

ABSTRACT

Background Data: Degenerative lumbar spine, including spondylolisthesis, is a common clinical condition that affects humans in the most productive period of their life. There are many surgical options for the management of such conditions after the failure of conservative therapy. Recently, there has been a great debate regarding the use of minimally invasive (MI) versus open transforaminal lumbar interbody fusion (O-TLIF) in the treatment of single-level low-grade lumbar spondylolisthesis, so there was a need to reach a consensus over this issue.

Purpose: To compare the clinical efficacy and safety of MI-TLIF versus O-TLIF in the treatment of single-level low-grade degenerative lumbar spondylolisthesis.

Study Design: A systematic review for recent studies in the context and meta-analysis.

Patients and Methods: We searched online databases of PubMed, Google Scholar, Cochrane Library, and DOAJ (2016–2020), and the search yielded 1352 articles. Based on our inclusion and exclusion criteria, we included retrospective, prospective, and randomized control trials, which came down to 11 research articles. Operative time, blood loss, hospital stay, back pain scores (Visual Analogue Scale), functional score (Oswestry Disability Index), complication rate, and reoperation rate for both techniques were recorded and presented as means. We then performed a meta-analysis.

Results: There is an overall advantage for the MI-TLIF over the O-TLIF in different parameters. There was a statistically significant difference in blood loss of −0.954 ml (p = 0.000) and hospital stay of −1.19 days (P = 0.000), favoring M-TLIF. There was a statistically insignificant difference in the total operative time (P = 0.071), the postoperative VAS of −0.22 (P = 0.384), and the postoperative ODI of −2 (P = 0.331). Moreover, there was a reduced combined odds ratio for complications and a reduced odds ratio for re-operation.

Address correspondence and reprint requests: Mohamed Hassan Mahmoud[1], MD.
Neurosurgery Department, Faculty of Medicine, Suez Canal University, Ismailia, Egypt.
Email: m.h.mahmoud@med.suez.edu.eg/m.h.mahmoud@outlook.com

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Conclusion: The reported data in this study suggest that there was a significant difference in operative blood loss and hospital stay between both groups that favor the MI-TLIF procedure. In contrast, there was no significant difference in operative time, VAS, ODI, reoperation rate, and rate of postoperative complications between both groups. (2021ESJ235)

Keywords: Lumbar spine, Spondylolisthesis, Fusion, Degenerative, TLIF, MIS

INTRODUCTION

Degenerative spondylolisthesis (DS) is an acquired anterior-vertebral displacement without disrupting the pars interarticularis, associated with the degenerative changes of aging, such as intervertebral disc degeneration, ligamentous hypertrophy or buckling, and osteophyte proliferation.[13,25,1] This clinical condition place enormous socioeconomic and health burdens on the health service providers and society.

Instrumented lumbar interbody fusion (LIF) is a commonly used surgical intervention to treat various kinds of lumbar disease requiring fusion. Recently, LIF using minimally invasive techniques, such as percutaneous pedicle screw fixation (PPSF), has been used frequently with the advancement of minimally invasive spinal technique (MIS).[5,10,17,36,38] The preferred approaches for this procedure are posterior lumbar interbody fusion (PLIF) [30,31] or transforaminal lumbar interbody fusion (TLIF).[3,7,11,21,29] In 2002, Foley and Lefkowitz[6] first introduced the minimally invasive transforaminal lumbar interbody fusion (MI-TLIF) technique. With the advancement of surgical instrumentation and optical systems, the MIS-TLIF technique has become more and more popular with the potential advantages of smaller wound size, less tissue trauma, and faster recovery.[27,35,37]

Recently, other approaches[12,47] have been performed; however, MI-TLIF has gained more popularity than others due to no thecal sac retraction and the lower level of trauma to back muscle and bony structures such as facet joints and lamina. Although many articles have reported O-TLIF or MI-TLIF, no studies have reported the long-term clinical and radiological outcomes of instrumented MI-TLIF. Other studies have reported the harmful effects of extensive muscle dissection and excessive blood loss due to this traditional O-TLIF procedure.[22,34,39] Up to now, no consensus has been reached regarding which procedure can achieve better effects in the treatment of symptomatic lumbar spondylolisthesis.[35]

This study was performed to estimate the clinical efficacy and safety of MI-TLIF versus O-TLIF in the management of single-level low-grade degenerative lumbar spondylolisthesis.

PATIENTS AND METHODS

Search Strategy: This study was performed according to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA).[23] The relevant literature retrieval was performed in 4 electronic databases, including PubMed, Google Scholar, Cochrane Library, and Directory of Open Access Journal (DOAJ). The final searches were performed on January 5th, 2021. Reference lists of included articles and relevant meta-analysis were manually searched. Randomized or nonrandomized controlled studies published from January 2016 to December 2020 that compared MI-TLIF with O-TLIF for the treatment of low-grade lumbar degenerative spondylolisthesis were retrieved.

We searched these databases using a combination of the keywords and medical subject headings. For maximum sensitivity of the search strategy, the search terms were combined as follows: 1) transforaminal lumbar interbody fusion OR TLIF OR open; 2) minimally invasive transforaminal lumbar interbody fusion OR MI-TLIF OR minimally invasive surgery; 3) single-level degenerative spondylolisthesis; 4) 1, 2, and 3. Only articles that were published in the English language were included. Citations abstracts and full

manuscripts were downloaded and de-duplicated for screening and categorization of potentially eligible studies. For degenerative spondylolisthesis, the initial searches were conducted independently by two reviewers (MHM, MS) to screen all retrieved titles and abstracts. Unqualifying studies were initially excluded, while the full text of eligible reports was assessed. The reference lists of all acquired articles were also manually checked for additional relevant studies. Discrepancies between them were resolved by discussion.

Inclusion Criteria. Eligibility criteria for study selection included in the present network meta-analysis are as follows: (1) an RCT and non-RCT published in English; (2) patients with degenerative lumbar spondylolisthesis; (3) comparing the 2-fusion procedure, MIS-TLIF, and O-TLIF; (4) treatment-specific outcomes including preoperative and postoperative VAS (Visual Analogue Score) and Oswestry Disability Index (ODI) scores, blood loss, operative time, hospital stay, reoperation rates, and complications; (5) an average follow-up duration of at least 12 months.

Exclusion Criteria: Studies were expelled according to the following items: (1) <10 patients per intervention arm,[19] (2) Observational studies, case reports, conference abstracts or paper, and duplicated papers or reviews, and (3) Qualified data from the original studies could not be extracted.

Search Results:

We searched online databases of PubMed, Google Scholar, Cochrane Library, and DOAJ (2016–2020), which yielded 1352 articles. We included retrospective, prospective, and randomized control trials based on our inclusion and exclusion criteria, which came down to 11 research articles. A PRISMA flowchart diagram depicting the study identification and selection process is shown in Figure 1. Data were extracted independently and duplicated from eligible studies by the same two researchers using standardized data collections forms developed *a priori*. Data items recorded included general manuscript information, patients' characteristics, study characteristics, treatment details, and main outcomes (Table 1). Data extraction discrepancies between the two researchers were resolved by discussion. Moreover, we have applied the quality check on the papers included according to the 8-Item Modified Jadad Scale, as explained in Table 2. Operative time, blood loss, hospital stay, pain scores (Visual Analogue Scale), functional score (Oswestry Disability Index), complication rate, and reoperation rate for both techniques were recorded and presented as means. We then performed a meta-analysis.

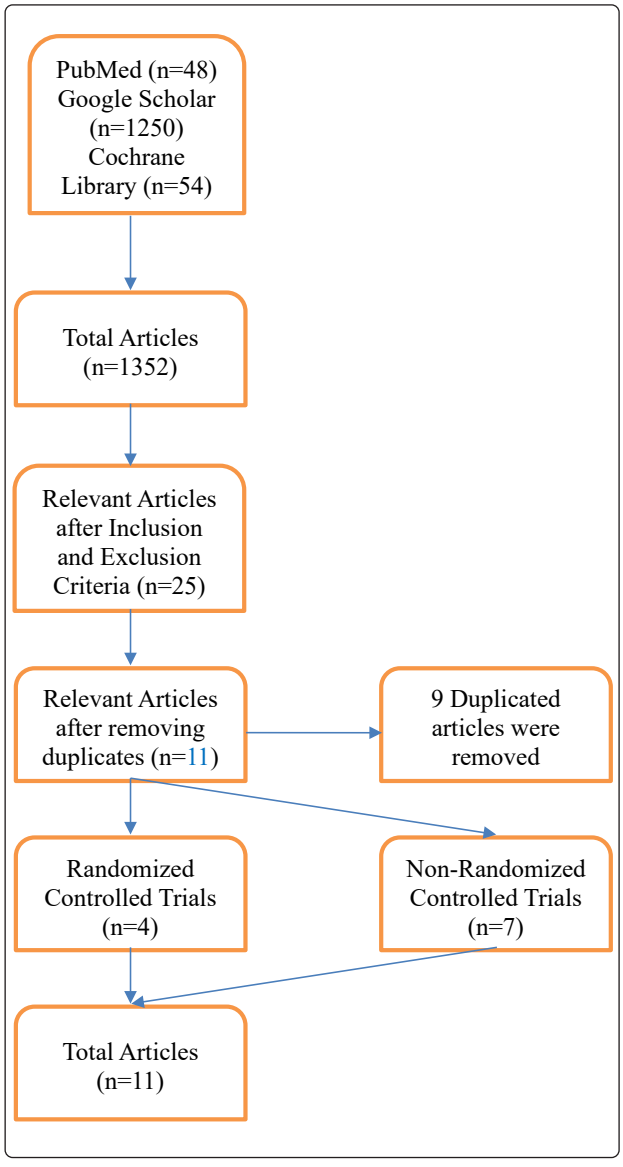

Figure 1. Flow diagram of the search strategy and study selection process.

Table 1. Summary of reported data in this meta-analysis

ID	Study	Design	Size	Age	M/F	BMI	F Up/ months	Preop. VAS	Postop. VAS	Preop. ODI	Postop. ODI	Op. Time	Blood Loss	Compli-cation	Fusion	Hospital stay	Reopera-tion
1	Yang et al., 2017 [46]	RCT	21/20	63.5/58	7/14 -8/12	23.7/ 25	24	5.8±0.9/ 5.6±0.8	1.0 ± 0.9/ 1.2±1.2	43.5 ± 15.1/ 44.2±14.3	12.0±6.4/ 13.5±6.5	179.0±20.7/ 141.8±18.8	188.6±42.3/ 293.0±78.9	2/21 / 1/20	85.70%/ 80%	N/A	N/A
2	Zhao et al., 2019 [48]	RCT	46/45	57.3/58.5	26/20-27/18	22.1/ 23.2	62/62	7.05±0.15 / 6.86±0.15	0.35±0.08/ 0.33±0.08	N/A	N/A	105.7±16.2/ 112.7±20.7	110.4±27.8/ 119.7±28.5	N/A	97.8%/ 97.78	N/A	4.35%/ 6.67%
3	Serban et al., 2017 [40]	RCT	40/40	51.3/50.1	16/42-17/23	29.9/ 28.9	12	N/A	N/A	37.75±6.59/ 38.35±7.58	11.52±6.56/ 11.67±6.09	321.92±85.57/ 296.22±101.01	351.25±198.87/ 417.5±211.69	0/40 / 1/40	90%/ 90%	1.92±0.52/ 4.12±0.88	N/A
4	Wang et al., 2016 [43]	RCT	20/20	50.6/51.5	7/13-10/10	25.27/ 25.3	24	N/A	N/A	52±11/ 34±10	12±2/9±2	134.4±27.9/ 124.5±23	122.5±100/ 220.5±191	2/20 / 3/20	N/A	8.8±2.1/ 12.3±2.3	0%/0%
5	Chan et al., 2020 [2]	Prospec-tive	72/225	62.1/59.5	32/40-82/143	29.5/ 31.3	24	6.9±2.6 / 7±2.3	2.3±2.9/ 3.5±2.9	46.2±16.3/ 48±16.6	14.3±17.2/ 24±19.8	228.2±111.5/ 189.6±66.5	108±85.6/ 299.6±242.2	5/72 / 17/225	100%/ 96.4%	2.9±1.8/ 3.3±1.6	1.4%/7.1%
6	Wu et al., 2018 [44]	Retro-spective	79/88	58.1/55.3	33/46-38/50	N/A	24-60	6.78±1.48 / 6.7±1.53	1.63±1.2/ 1.84±0.99	60.7±10.6/ 62.1±10.6	25.3±6.3/ 25.3±6.2	145.5±21.5/ 151.4±19.9	163.7±49.6/ 243.3±70.2	7/79 / 10/88	N/A	5.8±1.4/ 7.3±2.9	3.8%/ 2.27%
7	Peng et al., 2020 [33]	Retro-spective	18/22	55.6/56.6	5/13-5/17	N/A	5.9/5.6	0.61±0.5/ 0.86±0.63	N/A	N/A	201.67±29.15/ 132.27±23.64	88.33±23.57/ 255.91±50.95	0/18 / 0/22	N/A	10.33±2.47/ 13.64±3.91	N/A	
8	Kulkarni et al.,2020 [18]	Prospec-tive	36/25	51.5/50.4	10/26-11/14	28.22/ 26.43	N/A	N/A	N/A	N/A	N/A	204/177.5	111.47/358.8	2/25 / 0/36	N/A	4.11/5.84	N/A
9	Mum-maneni et al., 2017 [28]	Retro review of QOD	76/181	59/60.9	34/42-66/115	31/ 31.1	12	N/A	N/A	N/A	N/A	N/A	143±116/ 290±22	N/A	N/A	3.21±1.74/ 3.36±1.55	5.26%/5%
10	Su et al., 2019 [42]	Retro of prosp data	25/23	64/62	6/19-5/18	N/A	19/19	N/A	N/A	N/A	N/A	N/A	103.2±16.9/ 130.5±17.9	N/A	N/A	N/A	N/A
11	Lv et al., 2017 [24]	Prospec-tive	50/56	N/A	N/A	N/A	36	6.81±0.8 / 7.12±0.9	2.36±0.29/ 2.82±0.39	58±8.8/ 56±7.5	14.2±3.3/ 16.8±3.9	103.2±16.9/ 130.5±17.9	N/A	2/50 / 1/56	N/A	5.4±2.8/ 7.1±3.3	N/A

Preop: preoperative, Postop: postoperative, Op: operative, QOD: Quality Outcomes Database, Retrosp: retrospective, Prosp: prospective. Data ordered as MI-TLIF/O-TLIF

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Table 2. Quality evaluation according to the 8-Item Modified Jadad Scale.

Items Assessed	Yang et al., 2017 [46]	Zhao et al., 2019 [48]	Serban et al., 2017 [40]	Wang et al., 2016 [43]	Wu et al., 2018 [44]	Peng et al., 2020 [33]	Kulkarni et al.,2020 [18]	Mummaneni et al., 2017 [28]	Su et al., 2019 [42]	Lv et al., 2017 [24]	Chan et al., 2020 [2]
Was the study described as randomized?	Yes	Yes	Yes	Yes	No	No	No	No	No	No	No
Was the method of randomization appropriate?	Yes	Yes	Yes	Yes	NA	NA	NA	NA	NA	N/A	N/A
Was the study described as blinded?	NA	NA	Yes	Yes	NA	NA	NA	NA	NA	N/A	N/A
Was the method of blinding appropriate?	NA	NA	Yes	Yes	NA	NA	NA	NA	NA	N/A	N/A
Was there a description of withdrawals and dropouts?	NA	NA	NA	NA	NA	NA	NA	NA	NA	N/A	N/A
Was there a clear description of the inclusion/exclusion criteria?	Yes	NA	Yes	NA	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Was the method used to assess adverse effects described?	Yes	Yes	Yes	NA	Yes	Yes	Yes	NA	NA	Yes	Yes
Was the method of statistical analysis described?	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Total scores	5	4	7	5	3	3	3	2	2	3	3

Statistical Analysis:

We analyzed data from the included studies using Comprehensive Meta-analysis (Biostat Inc., Englewood, NJ, USA), Open Meta Analyst (Wallace, Byron C., Issa J. Dahabreh, Thomas A.), and Microsoft Excel 2016 (Microsoft Corp., Redmond, WA, USA). A formal meta-analysis was conducted for all outcomes if the data were sufficient. We expressed pooled dichotomous data as odds ratio (OR) with 95% confidence intervals (95% confidence interval (CI)), while pooled continuous effect measures were expressed as the mean difference with 95% CI. We explored and quantified between-study statistical heterogeneity using the I2 test. By default, we used the fixed-effects model in all analyses. If heterogeneity was statistically significant ($P < 0.05$) or I2 was > 0%, we used the Der Simonian and Laird random-effects model instead. Statistical analyses were two-sided with an α-error of 0.05.

RESULTS

Eleven studies were reported in this systematic review, including four randomized controlled trials (RCT)[40,43,46,48] and seven nonrandomized controlled trials.[2,18,24,28,33,42,44] The summary of our extracted data and reported articles is presented in Table 1. The total number of patients was 1228, of which 745 patients underwent O-TLIF and 483 patients underwent MI-TLIF. The mean age was 57.3 years in the MI-TLIF group and 56.3 years in the O-TLIF group, while the total mean age was 56.8 years. The gender reported in this review showed that 445 were males and 677 were females, excluding Lv et al.'s[24] study (n = 106), who did not consider the count of separate genders. In the MI-TLIF approach, the male/female was 176/257, while in the O-TLIF approach, the male/female was 269/420.

According to the operated spinal levels in this review, the L2-L3 level affected 6% of the patients, the L3-L4 level 10%, the L4-L5 level 49%, and the L5-S1 level 35%. According to the degree of slippage, 92% of the patients had grade I and 8% had grade II lumbar spondylolisthesis. The mean follow-up was 23 months in MI-TLIF and 26.1 months in O-TLIF, while the total mean follow-up was 24.55 months in the whole group.

Operative Time:

Nine studies had sufficient data regarding the operative time. The mean operative time was 180.40 ± 69.1 minutes in the MI-TLIF group and 161.83 ± 56.18 minutes in the O-TLIF group. Based on our meta-analysis, there was no statistical significance between both procedures ($P \leq 0.071$) (Figure 2).

Blood Loss:

Ten studies had sufficient data regarding the amount of operative blood loss. The mean operative blood loss volume was 149.13 ± 77.26 ml in the MI-TLIF group and 287.44 ± 127.12 ml in the O-TLIF group. The difference was significant and favored the MI-TLIF procedure ($P \leq 0.001$) (Figure 3).

Hospital Stay:

Eight studies had sufficient information on the length of hospital stay. The mean hospital stay was 5.3 ± 2.9 days in the MI-TLIF group and 7.12 ± 3.9 days in the O-TLIF group. The difference was significant and favored the MI-TLIF procedure ($P \leq 0.001$) (Figure 4).

Low Back Pain Visual Analogue Score:

Six studies had sufficient data regarding the VAS scores of LBP. The mean preoperative VAS score for LBP was 6.45 in the MI-TLIF group and 6.37 in the O-TLIF group, with no statistically significant difference ($P = 0.388$) (Figure 5). The mean VAS score for postoperative LBP at the final follow-up was 1.19 in the MI-TLIF group and 1.41 in the O-TLIF group with no statistically significant difference between both procedures ($P = 0.137$) (Figure 6). There were marked differences and significant improvement between the preoperative and the postoperative VAS at the final follow-up in both procedures.

Oswestry Disability Index:

Six studies reported sufficient data on the ODI scores expressed in percentage. The mean preoperative ODI score was 46.38 in the MI-TLIF group and 45.13 in the O-TLIF group. The difference between both groups was not statistically significant ($P = 0.320$) (Figure 7). At the final follow-up, the mean ODI score was 18.63 in the MI-TLIF group and 20.63 in the O-TLIF group, with no significant difference between both groups ($P = 0.331$) (Figure 8). There were marked differences and significant improvement between the preoperative and the postoperative ODI at the final follow-up in both procedures.

Complications:

The number and details of complications have been reported in seven studies. The complication rate was 2.14% in the MI-TLIF group and 2.28% in the O-TLIF group. The difference between both groups was not statistically significant ($P = 0.634$) (Figure 9). Reported complications in seven studies were minor in general and included incidental dural tear, added neurological deficit, screw malposition, cage migration, wound infections, delayed wound healing, pseudoarthrosis, large seroma, large symptomatic seroma, contralateral radiculopathy, myocardial infarction, urinary tract infections, and bowel and bladder incontinence.

Reoperation Rate:

Four studies reported sufficient data on the reoperation rate expressed in percentage. The mean percentage of reoperation in the MI-TLIF group was 2% and 6% in the O-TLIF group, without any statistically significant difference between the two groups ($P = 0.758$) (Figure 10). The most common causes of reported reoperation in the study articles were adjacent segment disease, pseudoarthrosis, surgical site infection, contralateral radiculopathy, and implant-related complications, including cage and screw repositioning.

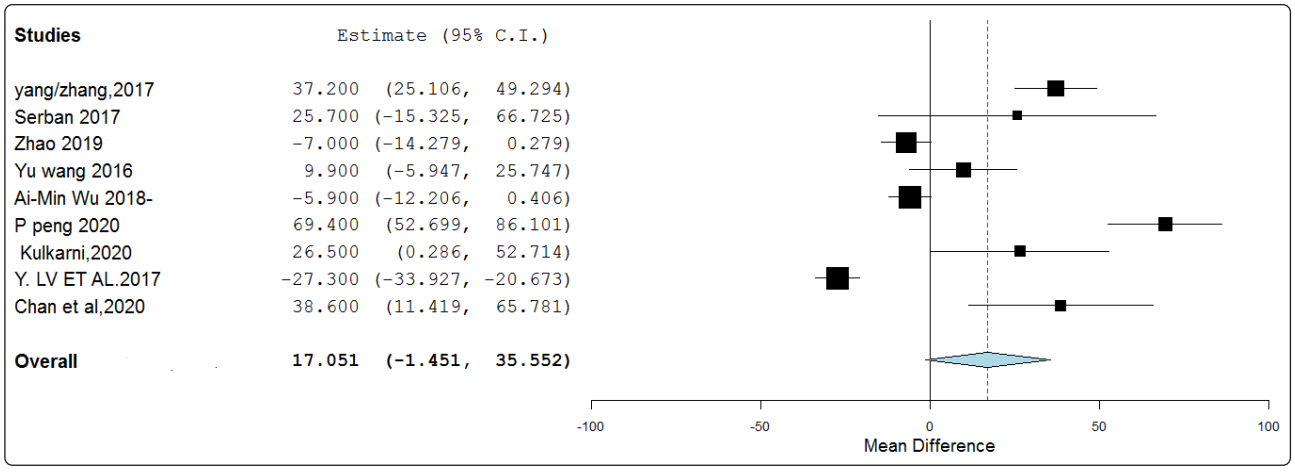

Figure 2. Forest plot for operation times, difference, total, and 95% CI. There is a difference in a total time of 17.052 mins (-1.1448 < 95%CI < 35.552) and p = <0.071 (not statistically significant); standard error: 9.439.

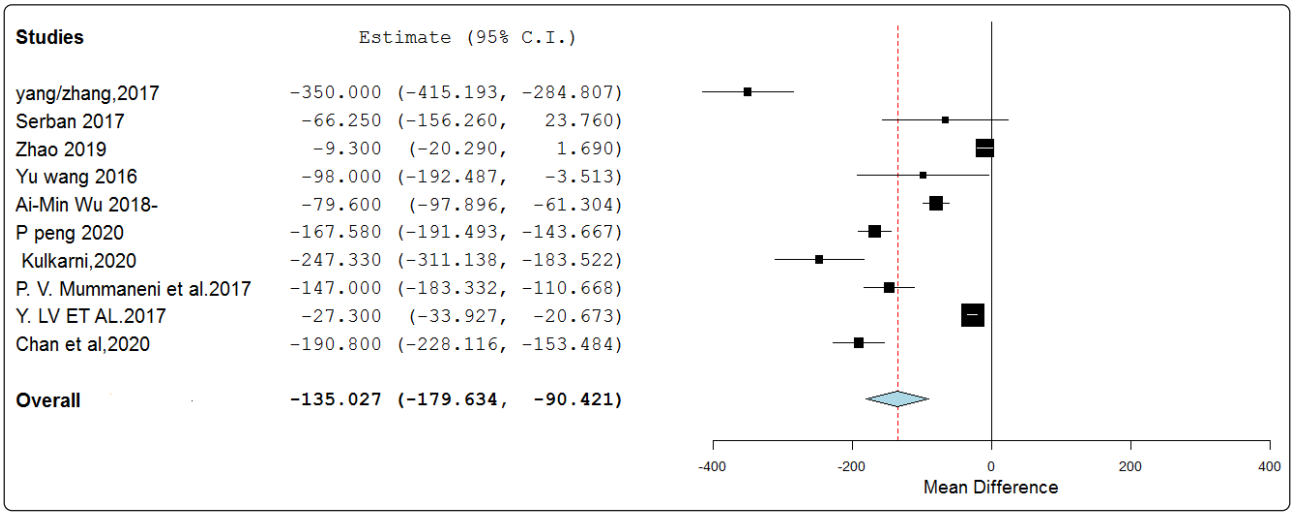

Figure 3. Forest plot for blood loss, difference, total, and 95% CI. There is a difference in blood loss of -135.027 (-179.634< 95%CI <-90.421); p < 0.001. Standard error: 22.759.

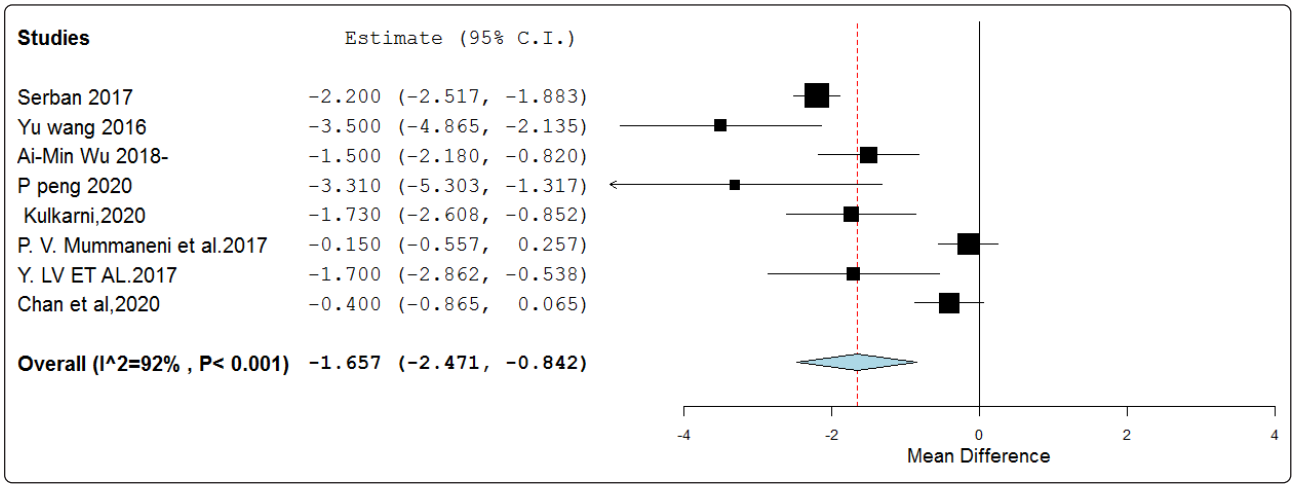

Figure 4. Forest plot for hospital stay, difference, total, and 95% CI. There is a difference in hospital stay of -1.657 days (-2.471 < 95%CI <-0.842); p < 0.001. Standard error: 0.415.

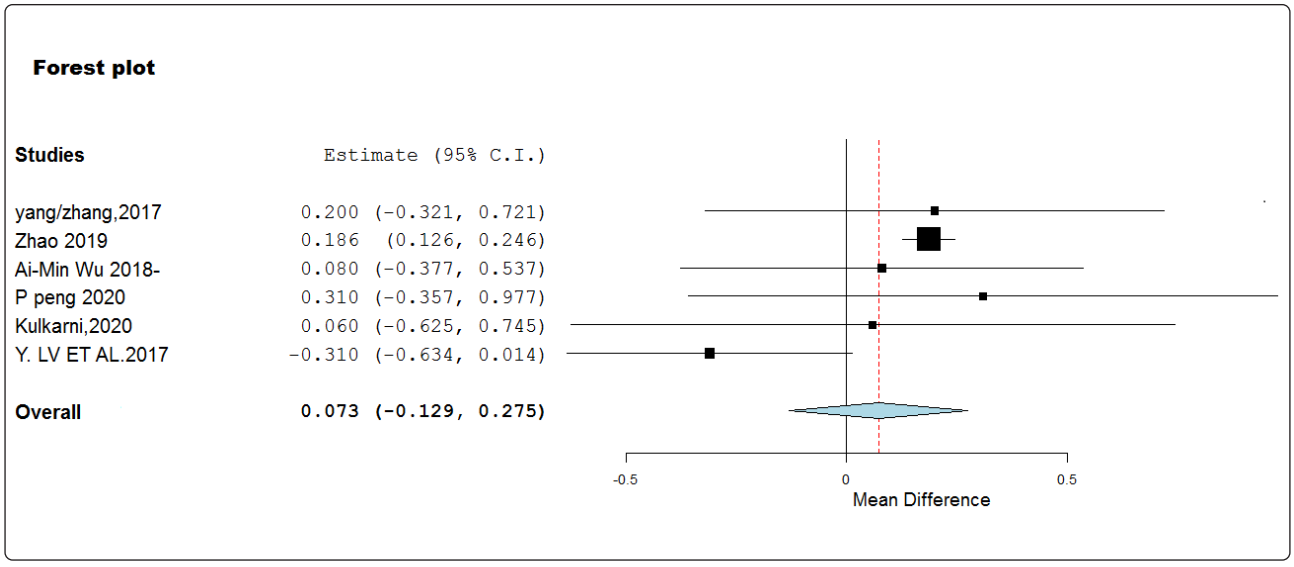

Figure 5. Forest plot for preoperative VAS, difference, total, and 95% CI. There is a difference in preoperative VAS of 0.073 (-0.129 < 95%CI < 0.275) and p = 0.388.

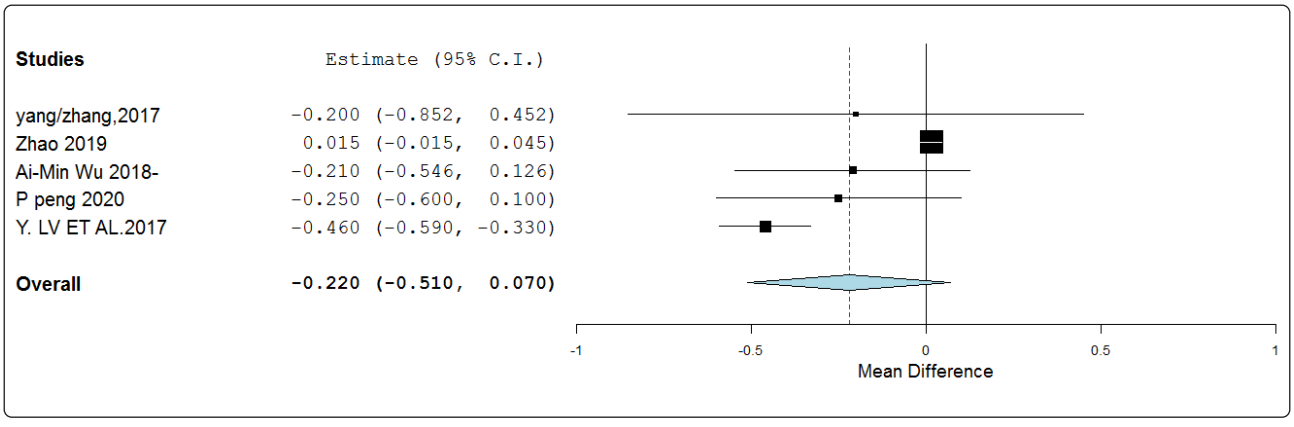

Figure 6. Forest plot for postoperative VAS, difference, total, and 95% CI. There is a difference in postoperative VAS of -0.220 (-0.510 < 95%CI < 0.070); p value = 0.137. Standard error: 0.148.

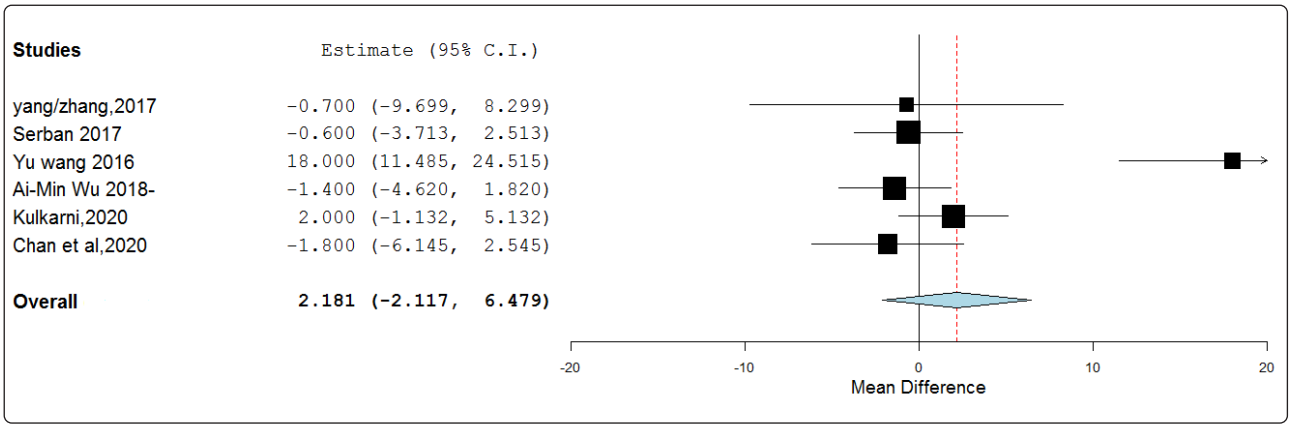

Figure 7. Forest plot for preoperative ODI, difference, total, and 95% CI. There is a difference in preoperative ODI of 2.181 (-2.117 < 95%CI < 6.479); p value = 0.320. Standard error: 2.193.

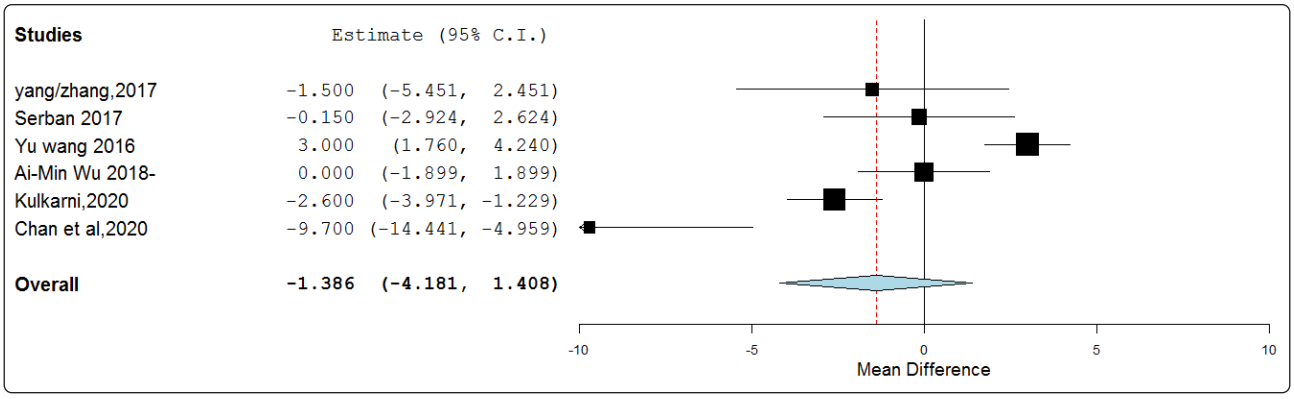

Figure 8. Forest plot for last F/U ODI, difference, total, and 95% CI. There is a difference in the last F/U ODI of -1.386 (-4.181 < 95%CI < 1.408); p value = 0.331. Standard error: 1.426.

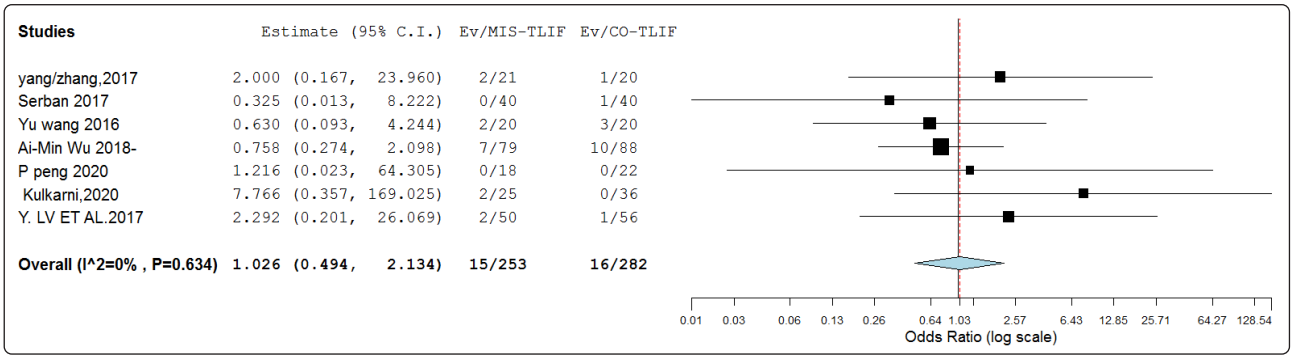

Figure 9. Forest plot for complications, OR and 95% CI. There is a difference in complications of 1.026 (0.494 < 95%CI < 2.134) and p value = 0.634 (not statistically significant).

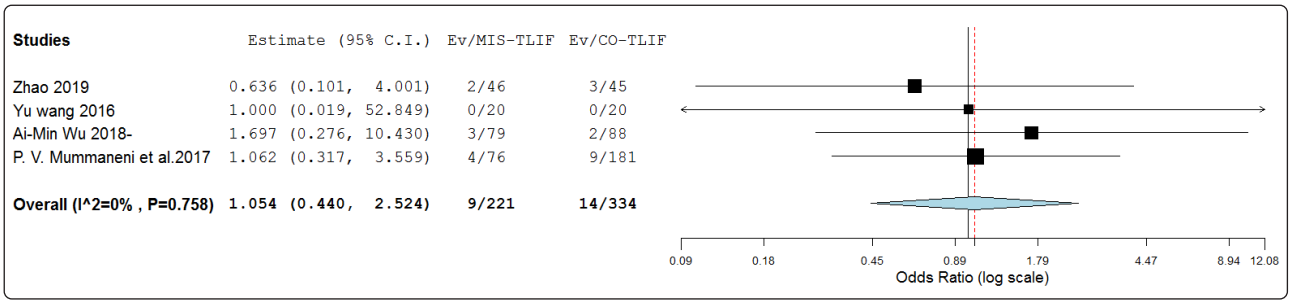

Figure 10. Forest plot for reoperation rate, OR and 95% CI. There is a difference in reoperation rate of 1.054 and (0.440 < 95%CI < 2.524) and p value = 0.758.

DISCUSSION

Compared to the standard PLIF, the posterolateral approach utilized in TLIF offered adequate exposure of the disc space through unilateral facetectomy, thus reducing retraction on thecal sac and nerve root while preserving contralateral anatomy. There is no consensus whether the MI-TLIF offered a better clinical outcome relative to O-TLIF. This systematic review and meta-analysis compared the MI-TLIF versus O-TLIF in low-grade lumbar spondylolisthesis. It is one of the ongoing efforts to compare the outcomes of O-TLIF and MI-TLIF by reviewing what has been published in the literature, considering that the use of MI-TLIF is still growing among spine surgeons regarding knowledge and skills. We reviewed 11 case studies, including four randomized controlled trials [40,43,46,48] and seven nonrandomized controlled

trials[2,18,24,28,33,42,44] to compare the clinical outcomes of patients who underwent either O-TLIF or MI-TLIF. The main findings of this review have shown a significant difference in operative blood loss and hospital stay between both groups that favour MI-TLIF procedure. While there was no significant difference in operative time, LBP VAS, ODI, reoperation rate and rate of postoperative complications between both groups.

The traditional O-TLIF technique is a midline approach with dissection of paraspinal muscles to expose the spinous process, laminae, and facet joints to perform neural decompression and interbody fusion.[9] Postoperative pain and operative blood loss are significant problems of O-TLIF.[22,34,39] MI lumbar surgeries were introduced 20 years ago by Foley[5,6] as an alternative to open traditional surgeries. The MI-TLIF approach via the Wiltse plan was one of the MI initiative procedures with minimal muscle stripping, retraction, and hence injury.[6,14,15] For beginners, the challenges of MI-TLIF lie in the steep learning curve and the longer operative time.[18]

We reviewed previous similar systematic reviews reporting the outcome of MI-TLIF and O-TLIF in treating single-level low-grade lumbar spondylolisthesis or mixed indications and reported three studies.[8,26,35] Qin et al.[35] (2000–2018) reported 394 in six articles, including two RCTs and four retrospective or prospective cohort studies. Hammad et al.[8] (2000-2017) reported 2385 patients in 32 studies, including one RCT and 13 retrospective and 18 prospective cohort studies. Miller et al.[26] reported 496 in four RCTs. Kim et al.[16] (2009–2019) published a narrative review study that reported 2327 patients in 20 studies, including six RCTs (Table 3).

Back pain VAS has been reported in all and was similar in either MI-TLIF and O-TLIF in all reviews, which is in line with our study. While ODI was similar in both techniques in our study and Hammad et al.'s study[8], it was better in the MI-TLIF in Qin et al.[35] and slightly better in Miller et al.'s [26] reviews. Operative blood loss and hospital stay were shorter in MI-TLIF in our review and another three reviews. Operative time was longer in MI-TLIF in our study and Qin et al.'s review [35], while it was similar in both techniques in the other two reviews. This difference could be because both our study and Qin et al.'s review[35] reported only spondylolisthesis patients, while the other reviews reported mixed groups, including disc herniations and degeneration patients. As reported by Qin et al.[35] and Miller et al.[26], the fusion rate was similar in both groups. We did not report this parameter in our review. Similar back pain VAS and ODI may also reflect a similar fusion outcome indirectly among both groups.

Prolonged radiation exposure was reported in the MI-TLIF technique compared to the O-TLIF technique as reported by Hammad et al.[8] and Miller et al.[26]; this could also be explained by the fact that most of the reported studies and that of Qin et al.[35] are fairly recent compared to the other reviews, which reflect the learning curve and cumulative experience effect upon the technique itself. Our review showed that the reoperation rate was better in the MI-TLIF group than the O-TLIF group, while it was similar in both groups in Qin et al.'s[35] review. Although both reviews reported an identical group of patients, this difference may also be related to the surgeon experience and familiarity with the technique. Complication rate was similar in both groups in our review and Qin et al.[35], and Miller et al.[26] reviews, while it was better in the Hammad et al.[8] review.

Chan et al.[2] found that MI-TLIF has a less postoperative disability, a better quality of life, higher patients' satisfaction, faster return-to-work rate, and less blood loss than O-TLIF; however, MI-TLIF has prolonged operative times and a 5-fold lower rate of reoperation.[2] Wu et al.[45] reported better two-year pain outcomes following MI-TLIF compared to O-TLIF. In Qin et al.'s [35] study, O-TLIF has a higher risk of surgical site infection than MI-TLIF. Lv et al.[24] reported that there were no differences in the sagittal balance of the spine among the MI-TLIF and the O-TLIF groups postoperatively. Moreover, although there were no differences between the two groups

Table 3. Comparison of different outcome reported in previous systematic review and meta-analysis

Parameters	This Study	Qin et al.[35]	Hammad et al.[8]	Miller et al. [26]	Kim et al. [16]
Search span	2016-2020	2000-2018	2005-2017	NA	2009-2019
Search engine	PubMed, Google Scholar, Cochrane Library, DOAJ	PubMed, Embase, Cochrane Library	PubMed	PubMed, Google Scholar, Cochrane Library, DOAJ	PubMed, Embase, Google Scholar
Papers reported	11 including 4 RCTs	8 including 4 RCTs	32 including 1 RCT	4 RCTs	20 including 6 RCTs
Patients (MI-TLIF/O-TLIF)	1228 (483/745)	394 (182/212)	2385 (1285/1100)	496 (246/250)	2327 (1046/1281)
Indications	Low-grade spondylolisthesis	Low-grade spondylolisthesis	Mixed	Mixed	Posterior Lumbar Interbody Fusion
Visual Analogue Scale	No significant difference	Similar last follow-up back pain VAS	Similar last follow-up back pain VAS	Similar at short term	Slightly better in MI-TLIF
Oswestry Disability Index	No significant difference	Better in MI-TLIF	Similar last follow-up ODI	Slightly better in MI-TLIF	Slightly better in MI-TLIF
Operative time	No significant difference	More in MI-TLIF	Similar	Similar	Shorter in MI-TLIF
Radiation exposure	NA	NA	More in MI-TLIF	More in MI-TLIF	More in MI-TLIF
Operative blood loss	Less in MI-TLIF	Less in MI-TLIF	Less in MI-TLIF	Less in MI-TLIF	Less in MI-TLIF
Hospital stay	Shorter in MI-TLIF	Shorter in MI-TLIF	Shorter in MI-TLIF	Shorter in MI-TLIF	Shorter in MI-TLIF
Complication rate	No significant difference	Similar	Lower in MI-TLIF	Similar	Similar
Reoperation rate	No significant difference	Similar	NA	NA	Similar
Fusion rate	NA	Similar	NA	Similar	Similar

preoperatively in their study, they reported that MI-TLIF prevents paraspinal muscle atrophy compared with O-TLIF in a long-term follow-up.[24] Djurasovic et al.[4] reported that the direct costs at one year were $2493 lower in the MI-TLIF group than in the O-TLIF group. Shepard[41] suggested that the MI-TLIF is a more cost-effective intervention than O-TLIF. In a systematic review by Parker et al.,[32] they concluded that there was a significant decrease in the rate of surgical site infection after MI-TLIF compared with O-TLIF. Thus, MI-TLIF may be a better option in patients with high risks for perioperative wound infections, such as obese patients.[20] Mummaneni et al.[28] found no difference with regard to the length of hospital stay and 90-day return-to-work period. Su et al.'s [42] concluded in their study that in low-grade degenerative spondylolisthesis, both MI-TLIF and O-TLIF were associated with a significant reduction in vertebral slip; however, O-TLIF had a higher rate of slip reduction than MI-TLIF. They also reported that MI-TLIF significantly reduces lumbar lordosis and slip angle, resulting in relative kyphosis at the fused segment. Finally, they found that O-TLIF significantly reduces L1 axis and S1 distance and may be more conducive to improving lumbar sagittal balance. Contrary to their results, Serban et al.[40] reported similar radiological outcomes parameters among both M-TLIF and O-TLIF surgical groups.

This review has some limitations, including the paucity of RCTs and some reported studies not documenting the radiation exposure, fusion, sagittal balance, opioids use, and perioperative cost of each procedure. Multilevel and high-grade spondylolisthesis patients not reported here warrant more studies. More RCTs with a long-term follow-up are highly recommended with a focus on items mentioned in the limitations. Furthermore, important limitations are that some papers mixed other diagnoses with spondylolisthesis in the count pool of subjects, while some other papers counted grades I and II in the same counting pool.

CONCLUSION

The reported data in this systematic review and meta-analysis suggest that there was a significant difference in operative blood loss, and hospital stay between both groups that favor MI-TLIF versus O-TLIF procedure. While there was no significant difference in operative time, VAS, ODI, reoperation rate, and rate of postoperative complications between both groups.

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الملخص العربي

مراجعة منهجية وتحليل مفصل للتدخل الجراحي المحدود مقابل التثبيت التقليدي بين الفقرات القطنية في علاج الانزلاق الفقاري القطني منخفض الدرجة.

البيانات الخلفية: العمود الفقري القطني التنكسي بما في ذلك الانزلاق الفقاري هو حالة سريرية شائعة تؤثر على الإنسان في أكثر فترات حياته إنتاجية. هناك العديد من الخيارات الجراحية لعلاج مثل هذه الحالات بعد فشل العلاج التحفظي. في الآونة الأخيرة ، كان هناك نقاش كبير حول استخدام التدخل الجراحي المحدود مقابل التثبيت التقليدي بين الفقرات القطنية في علاج الانزلاق الفقاري القطني منخفض الدرجة ، لذلك كانت هناك حاجة للتوصل إلى إجماع حول هذه المشكلة.

الغرض: مقارنة الفعالية السريرية وسلامة التدخل الجراحي المحدود مقابل التثبيت التقليدي بين الفقرات القطنية في علاج الانزلاق الفقاري القطني منخفض الدرجة.

تصميم الدراسة: مراجعة منهجية وتحليل مفصل للدراسات الحديثة من ٢٠١٦ ل ٢٠٢٠.

المرضى و الطرق: بحثنا في قواعد البيانات عبر الإنترنت لـ PubMed و Google Scholar ومكتبةCochrane و DOAJ من ٢٠١٦ الى ٢٠٢٠ والتي أسفرت عن ١٣٥٢ مقالة. استنادًا إلى معايير التضمين والاستبعاد لدينا ، قمنا بتضمين ١١ مقالة بحثية منهم ٤ أبحاث تجربية عشوائية محكومة و ٧ مقالات علمية تجربية غير عشوائية و غير محكومة. تم تسجيل مدة الجراحة ، وكمية الدم المفقود ، ومدة الإقامة في المستشفى، ودرجات آلام الظهر (عن طريق المقياس التناظري البصري) ، والنتيجة الوظيفية (عن طريق مؤشر اويستري للإعاقة) ، ومعدل المضاعفات الجراحية ، وعدد المرضى المحتاجين لجراحة أخرى. وقمنا بمراجعة منهجية وتحليل مفصل.

النتائج: كان هناك فرق احصائى للتدخل الجراحي المحدود مقابل التثبيت التقليدي بين الفقرات القطنية في كم الدم المفقود (معامل احصائي: ٠,٠٠٠) ومدة الإقامة في المستشفى(معامل احصائي: ٠,٠٠٠). كما أثبتنا ان لا يوجد فرق احصائي في مدة الجراحة (معامل احصائي: ٠,٠٧١) ودرجات آلام الظهر ما بعد الجراحة (عن طريق المقياس التناظري البصري) (معامل احصائي: ٠,٣٨٤)، والنتيجة الوظيفية ما بعد الجراحة (عن طريق مؤشر اويستري للإعاقة) (معامل احصائي: ٠,٣٣١). وكانت هناك نسبة احتمالات مخفضة مجمعة للمضاعفات الجراحية ، وعدد المرضى المحتاجين لجراحة أخرى.

الخلاصة: تشير البيانات الواردة في هذه الدراسة إلى فرق احصائى للتدخل الجراحي المحدود مقابل التثبيت التقليدي بين الفقرات القطنية في كم الدم المفقود ومدة الإقامة في المستشفى. كما أثبتنا ان لا يوجد فرق احصائي في مدة الجراحة ودرجات آلام الظهر (عن طريق المقياس التناظري البصري)، والنتيجة الوظيفية (عن طريق مؤشر اويستري للإعاقة) ونسبة احتمالات للمضاعفات الجراحية، وعدد المرضى المحتاجين لجراحة أخرى.