



Comparison of lumbar pedicular dynamic stabilisation systems versus fusion for the treatment of lumbar degenerative disc disease: A meta-analysis

Yong-Jing HUANG, Shu-Jie ZHAO, Qiang ZHANG, Lu-Ming NONG, Nan-Wei XU

From the Department of Orthopedics, The Affiliated Changzhou No. 2 Hospital of Nanjing Medical University, Changzhou city, Jiangsu Province, China

This study aimed to systematically compare the safety, effectiveness and radiological changes after lumbar pedicular dynamic stabilisation systems and fusion to treat lumbar degenerative disc disease .

All studies that were performed to compare various lumbar pedicular dynamic stabilisation systems with any lumbar fusion to treat lumbar degenerative disc disease and were published until April 30, 2015 were acquired through a comprehensive search in various databases. A meta-analysis was performed after the methodological qualities of trials were assessed and after data were extracted.

Sixteen trials with 881 patients with a short-term follow-up (within 2 years) and a middle-term follow-up (2 to 4 years) were identified. Patients treated with lumbar pedicular dynamic stabilisation systems experienced more significant advantages in terms of operation time, intra-operative blood loss, complications and adjacent segment degeneration/disease development than those treated with lumbar fusion. The two groups did not significantly differ in terms of improvement in Oswestry Disability Index, visual analogue scale scores, satisfaction rate of operation and range of motion of adjacent segments. Lumbar pedicular dynamic stabilisation systems is superior to lumbar fusion to some extent, although some of its advantages have yet to be verified and compared with those of lumbar fusion. However, the two interventions were not significantly different in terms of relief in symptoms, functional recovery and motion preservation. Thus, lumbar pedicular dynamic stabilisation systems is recommended for its safety. A prudent attitude is necessary to choose between

these interventions on the basis of effectiveness and changes in adjacent segments before a large-scale and long-term follow-up study can be performed.

Keywords : meta-analysis ; lumbar pedicular dynamic stabilisation system ; lumbar fusion ; lumbar degenerative disc disease.

INTRODUCTION

Lumbar degenerative disc disease (LDDD) is an important factor causing chronic lumbar back pain with lumbar segment instability. Lumbar fusion has been considered as a gold standard of the surgical management of LDDD with or without

- Yong-Jing Huang
- Shu-Jie Zhao
- Qiang Zhang
- Lu-Ming Nong
- Nan-Wei Xu

Department of Orthopedics, The Affiliated Changzhou No. 2 Hospital of Nanjing Medical University, Changzhou city, Jiangsu Province, China.

Correspondence : Lu-Ming Nong, Department of Orthopedics, The Affiliated Changzhou No. 2 Hospital of Nanjing Medical University, Changzhou city, Jiangsu Province, China. Tel : 0519-88123773.

E-mail : 18351229571@163.com.

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instability when conservative treatment fails; lumbar fusion can reduce or eliminate low back pain (LBP) by redressing abnormal motion and instability at symptomatic degeneration levels. Resnick DK et al. (29) reported that radiographic fusion rates are higher than 95%. However, high fusion rates are also accompanied by problems and potential complications, including non-union, instrumentation failure, infection and donor site pain. Moreover, the increased movement of adjacent segment after lumbar fusion may accelerate degeneration after spinal fusion; as a result, the risk of adjacent segment degeneration/disease (ASD) increases (1,11,14,22). With the potential disadvantages of fusion, various lumbar pedicular dynamic stabilisation systems (LPDSS) have been developed as a new technique that can effectively unload disc/facet joints, preserve motion under mechanical load and restrict the abnormal motion of adjacent segments compared with lumbar fusion (20) whose theoretical advantages are based on the immobilisation of the injured segment to prevent further injury and to share the load across the bridged segment. LPDSS includes Dynamic Stabilisation System (DSS, Zimmer Spine, Inc., Warsaw, IN, USA), Isobar TTL Dynamic Stabilisation System (Scient'x, Bretonneux, France), Cosmic Dynamic Pedicular Screw-rod System (Ulrich GmbH & Co., KG, Ulm, Germany), Segmental Spinal Correction System (SSCS) (Ulrich GmbH & Co., KG, Ulm, Germany) and Twinfle Dynamic Stabilisation System. Dynamic stabilisation devices have been designed 1) to control the neutral posture of a segment, 2) to control the sagittal plane bending of the treated level, 3) to unload the intervertebral disk at the treated level and 4) to modify the distribution of loads within the segment, particularly within the intervertebral disk (15). Previous studies (2,5,7,8,12,13,16,17,23,33-39) compared the clinical effects of LPDSS with those of fusion to treat LDDD but revealed ambiguous results. Furthermore, studies have yet to determine specific surgical intervention techniques that benefit patients. Thus, this meta-analysis was performed to comprehensively compare the safety, effectiveness and changes in imaging with LPDSS and fusion for the treatment of LDDD.

MATERIALS AND METHODS

Search strategy

All studies published until April 2105 were electronically retrieved from PubMed, Cochrane Central Registry, Web of Science, MEDLINE, BIOSIS, Wan Fang and CNKI EMBASE. Spine, European Spine Journal, American and British versions of the Journal of Bone and Joint Surgery and reference lists in the selected studies were manually screened. The combinations of the following key words were used during retrieval: (lumbar pedicular dynamic stabilisation systems OR LPDSS OR flexible stabilisation OR nonrigid stabilisation OR nonfusion stabilisation OR Dynesys dynamic stabilisation system OR DSS OR Isobar TTL dynamic stabilisation system OR Cosmic dynamic pedicular screw-rod system OR Segmental spinal correction system OR SSCS OR Twinfle dynamic stabilisation) AND (lumbar fusion).

Inclusion and exclusion criteria

The studies were included in accordance with the following criteria: 1) participants subjected to surgical treatment and diagnosed with LBP with a degenerative lumbar disease; 2) all studies that compared lumbar pedicular dynamic stabilisation systems with fusion; 3) LPDSS devices used in dynamic fixation groups that included Dynesys Dynamic Stabilisation System or Isobar TTL Dynamic Stabilisation System or Cosmic Dynamic Pedicular Screw-rod System or SSCS or Twinfle Dynamic Stabilisation; 4) fusion groups treated with or without rigid stabilisation and 5) minimum sample size of 10 and follow-up of 1 year. Studies that included patients suffering from spinal infection, acute fracture, tumour, deformity, osteoporosis or rheumatoid arthritis were eliminated. Review articles, case reports and biomechanical and cadaveric studies were also excluded.

Data extraction

Two reviewers (Yong-Jing Huang and Shu-jie Zhao) independently extracted the relevant data

from the reports. Disagreements were resolved by a third referee. The extracted data described the characteristics of the investigations regarding study design, age, gender, LPDSS type, fusion type, hospitalisation duration and follow-up period. The outcomes pooled in this analysis included intra-operative blood loss, operating time, visual analogue scale (VAS), Oswestry disability index (ODI), satisfaction rate of operation, ASD, complications and range of motion (ROM) of adjacent segments. Evidence was evaluated using the checklist designed by Carney; in the checklist, good-quality RCT is classified as class I evidence, good-quality cohort studies and case control studies are categorised as class II evidence and case series are considered as class III evidence (3).

Statistical analysis

RevMan 5.0 software (Cochrane IMS) was used for the analysis. The results were expressed in terms of odds ratio (OR) and 95% confidence interval (95% CI) for dichotomous outcomes and in terms of mean difference (MD) and 95% CI for continuous outcomes. When the same

continuous outcomes were measured in different scales, standardised mean difference and 95% CI were calculated. I^2 statistics were used to test the statistical heterogeneity. If $I^2 > 50\%$, a random-effects model (REM) was employed, and the source of heterogeneity was investigated through subgroup and sensitivity analyses. Subgroup analysis was also performed on the basis of follow-up period or LPDSS device types; by contrast, sensitivity analysis was conducted by rejecting each article with high statistical heterogeneity. Alternatively, a fixed-effects model (FEM) was used (9). In this meta-analysis, the follow-up period varied from 1 year to more than 4 years; we divided the mean follow-up period into two subgroups: short term (within 2 years) and medium term (2 to 4 years). The subgroup analysis was performed on the basis of the two different mean follow-up periods. $P \leq 0.05$ was considered statistically significant.

RESULTS

Search results

Figure 1 shows the results of the search for relevant literature based on the strategy described

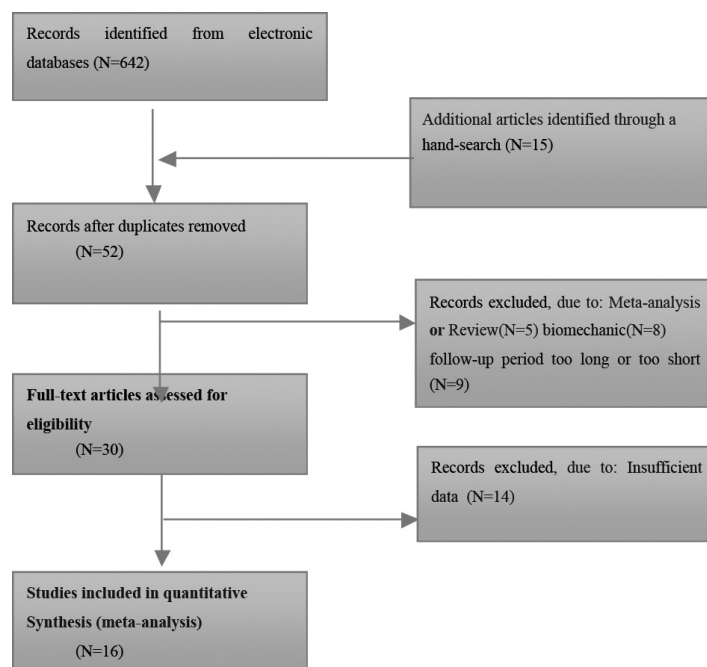


Fig. 1. — Process of relevant literature search.

above. A total of 16 articles (2,5,7,8,12,13,16,17,23,33-39) that enrolled 881 patients met the inclusion criteria. Six out of ten studies evaluated Caucasians and Asians. In addition, 5 different LPDSS were used: 11 studies used Dynesys, 2 used Isobar TTL dynamic stabilisation system and 3 studies used either the Cosmic Dynamic Pedicular Screw-rod System, SSCS, or Twinflex Dynamic Stabilisation. A total of 10 studies also identified one operated segment, 3 studies assessed multi segments, and the remaining 3 studies did not illustrate these details. Table I shows the concrete characteristics of the included studies.

Meta-analysis results

Intra-operative blood loss and operating time

A total of 12 studies reported intra-operative blood loss and operating time but only 8 of which provided data that may be used for comparison. The pooled results of the two groups demonstrated significant heterogeneity (Figures. 2 and 3). Those

trials were separately divided into two subgroups (e.g. Dynesys group and other dynamic fixation group or one operated segment group and multi segments group) based on LPDSS devices or on differences in operated segment. Enormous heterogeneity still existed, although all of the identified studies indicated intra-operative blood loss; the operating time in the dynamic fixation groups was obviously shorter than that in the fusion groups. Sensitivity analysis was performed and suggested that Yang ZX⁽³⁸⁾ highly influenced the overall results. The high level of heterogeneity may have caused by the differences in LPDSS devices or in the amount of operated segments. Moreover, the differences in the skill of surgeons is possibly another important reason for this heterogeneity.

Visual Analogue Score (VAS)

The intensity of pain was measured in a scale of 0 to 10, with a lower score representing a better condition. Overall, all included patients in

Table I. — Characteristics of the studies included in this meta-analysis.

Study ID	Study design	Case (D/F)	Sex ratio (M/F*)	Mean age(D/F)	No. of Operated (D/F*)	LPDDD device	Type of Fusion	Follow-up(D/F) (month)	Level of evidence
Kaner 2010[12]	PCS	26/20	13/33	63.7/58.1	1/1	CDPSS	PILF	36.15/35.92	II
Zhang J.S. 2011[39]	PCS	28/59	39/48	59.3/60.5	1.25/1.75	DSS	UA*	26	II
Fan Y.L. 2012[7]	RCS	12/12	12/12	53.9/55.7	1/1	DSS	PILF	18.9/16.9	III
Ma H. 2011[16]	PCS	16/16	15/17	49.9/51.5	1/1	ITDSS	PILF	15.8/15.8	II
Korovessis 2004[13]	RCT	15/15	UA*	UA*	2.5/2.8	TDSS	UA*	12/12	I
Yang B. 2013[34]	RCS	14/18	UA*	43.0/47.0	UA*	DSS	PILF	17/15	III
Ozer 2010[23]	PCS	19/22	15/26	59.3/60.5	UA*	LPDSS	PILF	24/24	II
Cakir 2009[2]	PCS	11/15	11/15	57.1/57.9	1/1	DSS	ALIF	37.5/45.3	II
Haddad 2012 [8]	RCS	32/32	34/30	40.6/46.5	UA	DSS	PILF	48/48	III
Silvestre 2014[5]	RCS	32/25	12/45	68.4/67.6	3.9/4.6	DSS	PILF	46/46	III
Yang M.Y. 2014[35]	PCS	30/45	38/37	55.9/54.7	2/2	DSS	PILF	26.6/26.0	II
Yu S.W. 2012[36]	RCT	27/29	21/35	52.2/55.5	1/1	DSS	PILF	36/36	I
Morishita 2011[17]	PCS	41/36	41/36	59.6/63.0	1/1	SSCS	TILF	36.2/35.9	II
Yang F. 2014[37]	RCS	26/34	35/25	42.5/45.2	1/1	DSS	PILF	38.4/38.4	III
Xiao J.F. 2014[33]	RCS	35/41	43/33	48.1/52.3	1/1	DSS	PILF	33.4/35.3	III
Yang Z.X. 2012[38]	PCS	52/46	68/30	66.1/65.1	UA*	ITDSS	PILF	36/36	II

*UA indicates that data are unavailable.

*M/F means male/female

*D/F means dynamic fixation groups /fusion groups

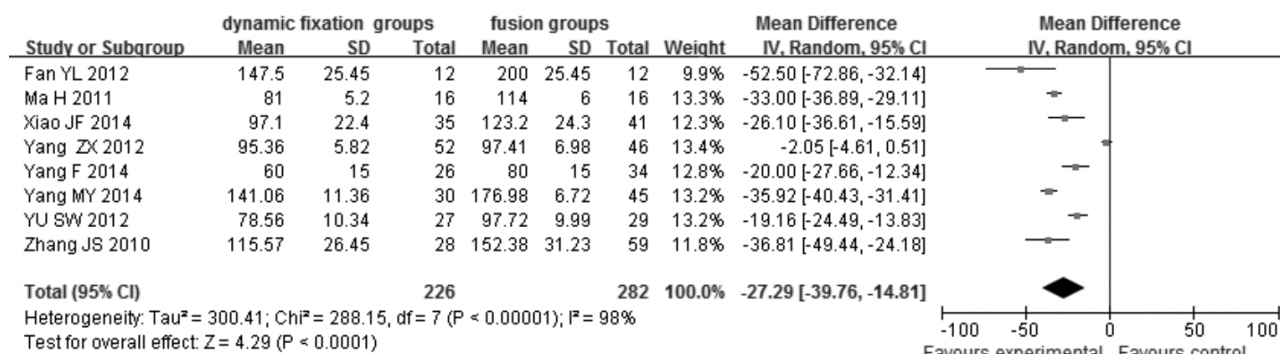


Fig. 2. — Results of the meta-analysis of operating time between dynamic fixation and fusion groups

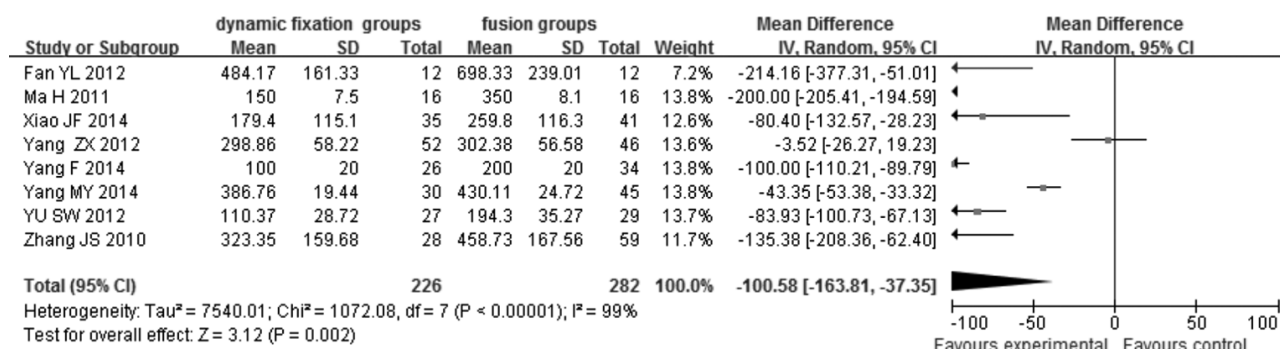


Fig. 3. — Result of the meta-analysis of intra-operative blood loss between dynamic fixation and fusion groups

the dynamic fixation groups and fusion groups have demonstrated significant improvement in their VAS scores compared with the preoperative scores during follow-up. In addition, the pooled analysis was performed on a short-term (within 2 years) and medium-term (2 to 4 years) bases. The estimated overall VAS of five studies were included in this meta-analysis. The test for heterogeneity demonstrated that no significant heterogeneity existed among the five studies ($P = 0.93$; $I^2 = 0\%$), so the fixed model was performed. The pooled results indicated that the patients treated with dynamic fixation showed no more relief in the short-term (MD, -0.15 ; 95% CI, -0.63 to 0.32 ; $P = 0.53$) or middle-term (MD, -0.66 ; 95% CI, -2.37 to 1.05 ; $P = 0.45$) (Fig. 4) follow-up compared with patients in the fusion group. Four studies (8,13,16,35) provided data on back and leg pain scores. Statistical significance was seen for the pain

relief in back (MD, -0.26 ; 95% CI, -0.34 to -0.17 ; $P < 0.00001$) (Fig. 5) except for leg (MD, 0.30 ; 95% CI, -0.48 to 1.07 ; $P = 0.45$) (Fig. 6) between the two groups.

ODI Questionnaire

The ODI is a validated questionnaire that assesses a patient's disability to perform daily activities. Apparently, the ODI scores of 12 included trials in both groups demonstrated significant improvement compared with the preoperative ODI scores during follow-up. Seven articles provided data for meta-analysis. The test for heterogeneity demonstrated that significant heterogeneity existed in the medium-term follow-up ($P < 0.0001$; $I^2 = 91\%$); Sensitivity analysis showed that Yang MY's study⁽³⁵⁾ significantly influenced the results. Moreover, the results suggested that the ODI

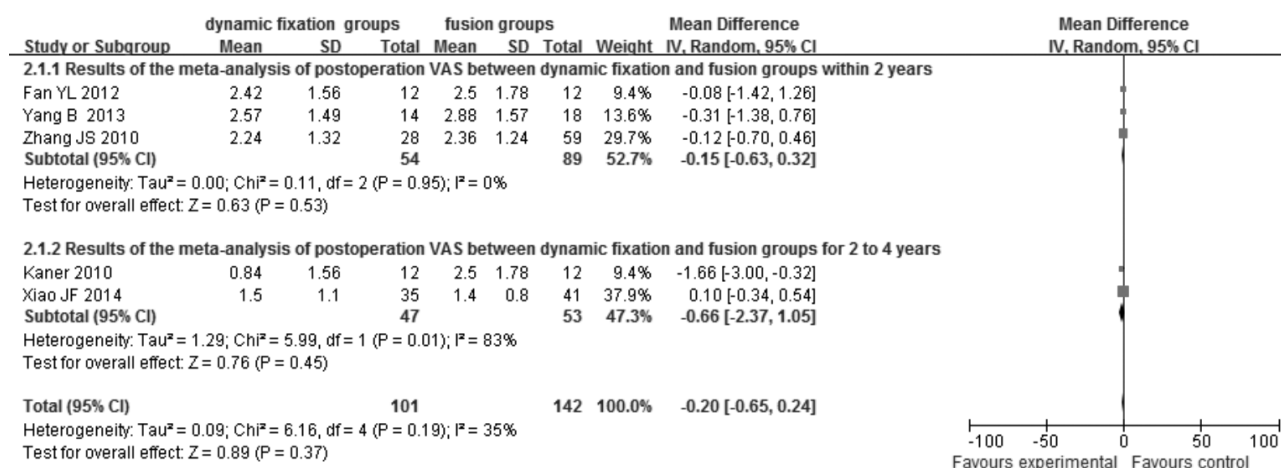


Fig. 4. — Results of the meta-analysis of postoperation VAS between dynamic fixation and fusion groups

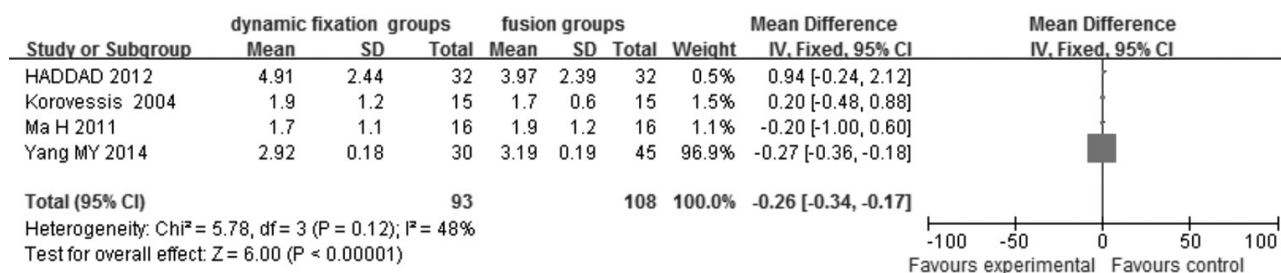


Fig. 5. — Results of the meta-analysis of postoperation back VAS between the dynamic fixation and fusion groups

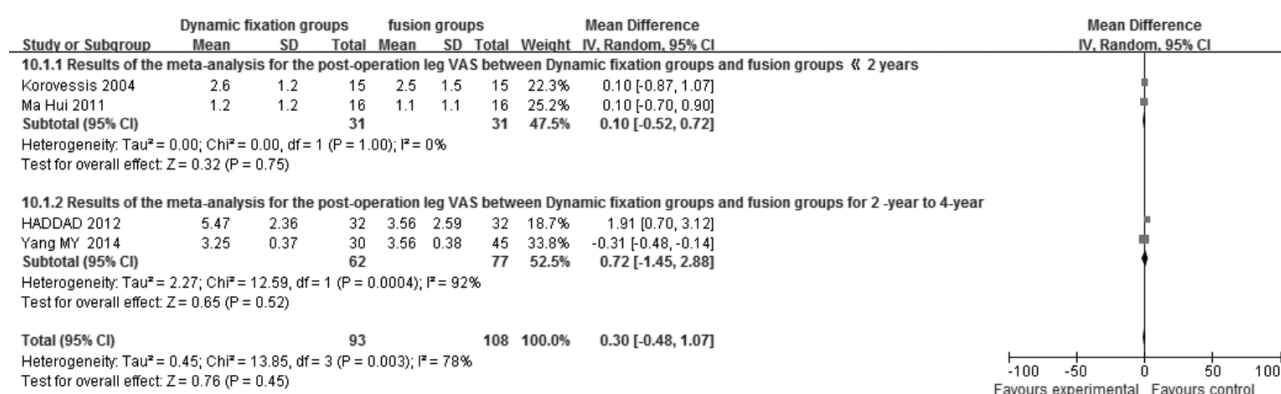


Fig. 6. — Results of the meta-analysis of postoperation leg VAS between dynamic fixation and fusion groups

of the two groups in the short-term follow-up (MD, -0.31; 95% CI, -2.68 to 2.07 ; P = 0.80) or medium-term follow-up (MD, -1.28; 95% CI, -6.21 to 3.65 ; P = 0.61) was not significantly different (Fig. 7). Yang MY, Yang F and Yu SW

(35-37) also investigated the degree of improvement in ODI. The test for heterogeneity demonstrated that significant heterogeneity (P = 0.001; I² = 85 %) existed, and the results showed that the patients treated with dynamic fixation displayed greater

degree of improvement in ODI (MD, 1.13 ; 95% CI, 0.31 to 1.96 ; P = 0.007) (Fig. 8) than those treated with fusion. Sensitivity analysis was performed to assess the influence of each study through the sequential removal of the studies, and the results confirmed the above outcome.

Length of hospitalisation and satisfaction rate of operation

Five trials (5,12,23,36,37) focused on the length of hospitalisation. A meta-analysis cannot be performed because only two trials reported continuous outcome measures in the form of mean ± SD, although all of the trials revealed an obviously lower mean days of hospitalisation in the dynamic fixation groups than in the fusion groups. In addition, four studies (7,8,35,39) reported on the

satisfaction rate of operation. REM was adopted because of the existence of slight heterogeneity (P = 0.11; I² = 51%). The results revealed that the patients in the two groups reported similar satisfaction rate to the two surgical interventions (OR, 1.02; 95% CI, 0.34 to 3.06; P = 0.97) (Fig. 9).

Complication and ASD

Ten studies (5,12,13,23,33,35-39) reported on the complications of the interventions. No significant results were obtained from the test for heterogeneity (P = 0.43; I² = 1%); thus, FEM was adopted and the pooled results suggested that the patients treated with dynamic fixation displayed less complications in both short-term follow-up (OR, 0.27; 95% CI, 0.08 to 0.87; P = 0.03) and medium-term (OR, 0.42; 95% CI, 0.23 to 0.76; P = 0.004)

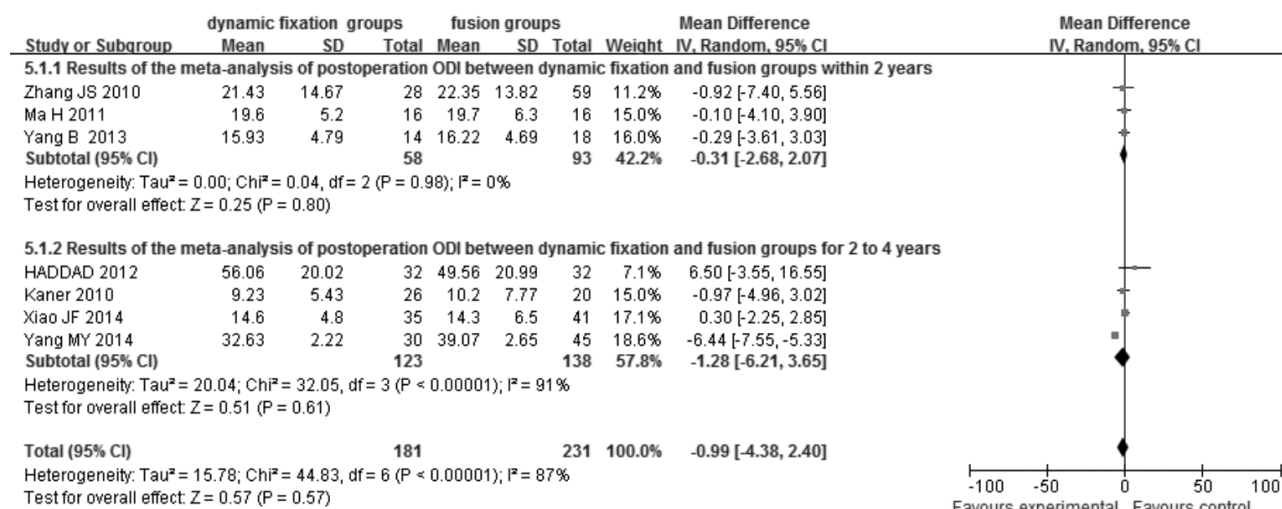


Fig. 7. — Results of the meta-analysis of postoperation ODI between dynamic fixation and fusion groups

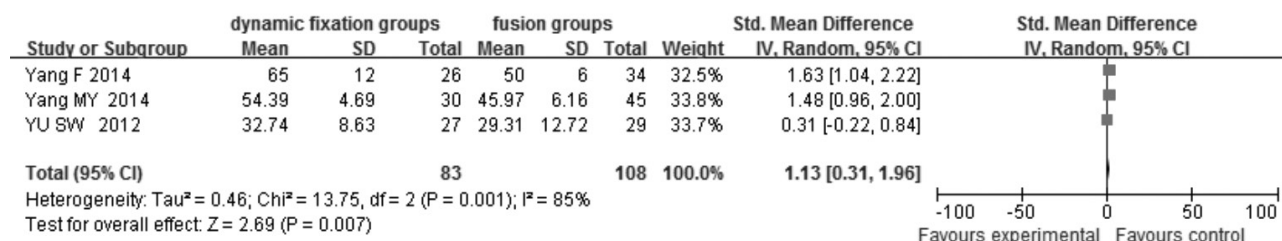


Fig. 8. — Results of the meta-analysis of the degree of improvement in ODI between dynamic fixation and fusion groups

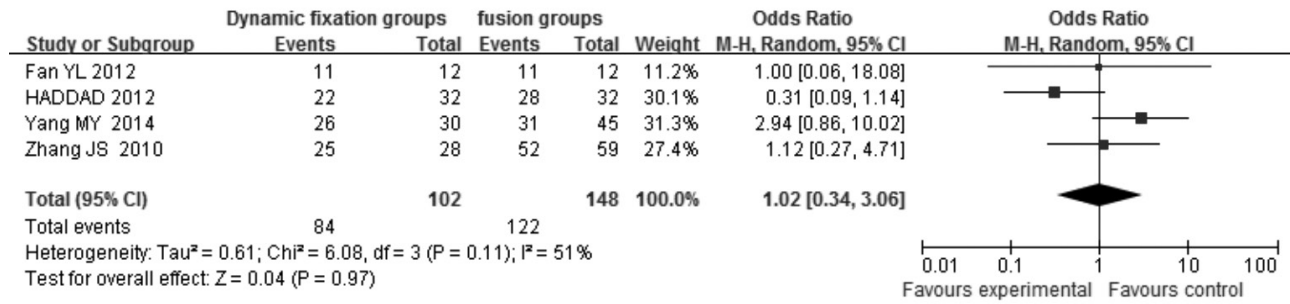


Fig. 9. — Results of the meta-analysis of the satisfaction rate of operation between dynamic fixation and fusion groups

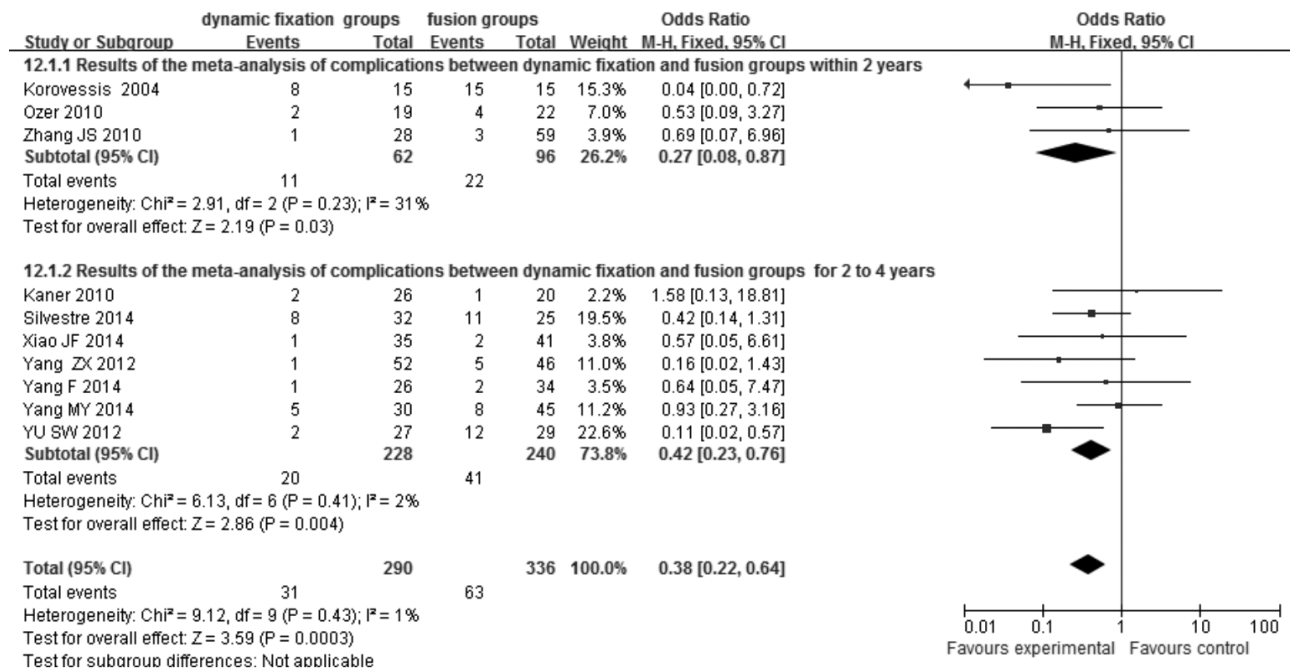


Fig. 10. — Results of the meta-analysis of complications between dynamic fixation and fusion groups

follow-up (Fig. 10) compared with the fusion group. Screw loosening/screw breakage were common postoperative complications of dynamic stabilisation; thus, we compared the available data from the included studies (8,13,23,35,36), and no significant difference (OR, 1.51; 95% CI, 0.57 to 3.98; P = 0.41) in screw loosening/screw breakage was observed between the two groups (Fig. 11). Given that only four studies (7,12,33,38) investigated the adjacent segment degeneration or disease(ASD), we combined and analysed them together. The outcome showed that the patients in the dynamic

fixation group showed less severe ASD (OR, 0.28; 95% CI, 0.13 to 0.57; P = 0.0005) (Fig. 12) than those in the fusion groups.

ROM

The ROM in the sagittal plane was measured by comparing the lateral flexion and extension radiographs. Six studies (2,7,16,33-35) compared the ROM of segments between preoperation and postoperation in both groups during follow-up. Fan YL et al. (2,7,16,33) investigated L4/5

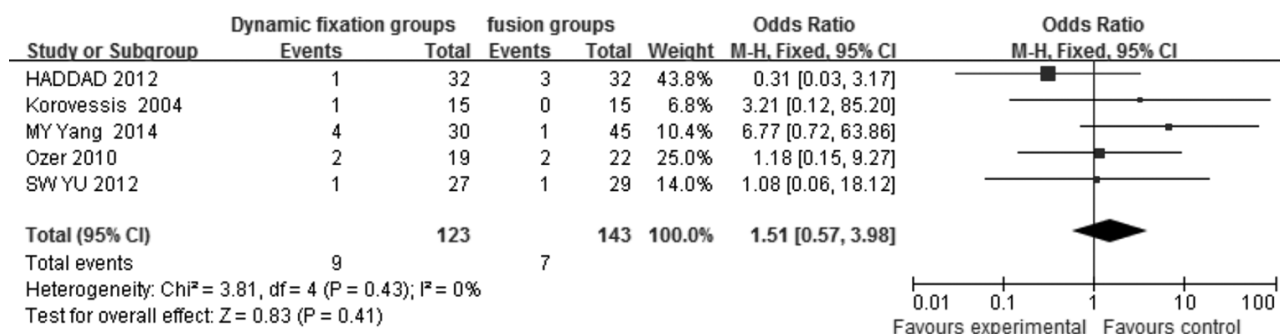


Fig. 11. — Results of the meta-analysis of screw loosening/screw breakage between dynamic fixation and fusion groups

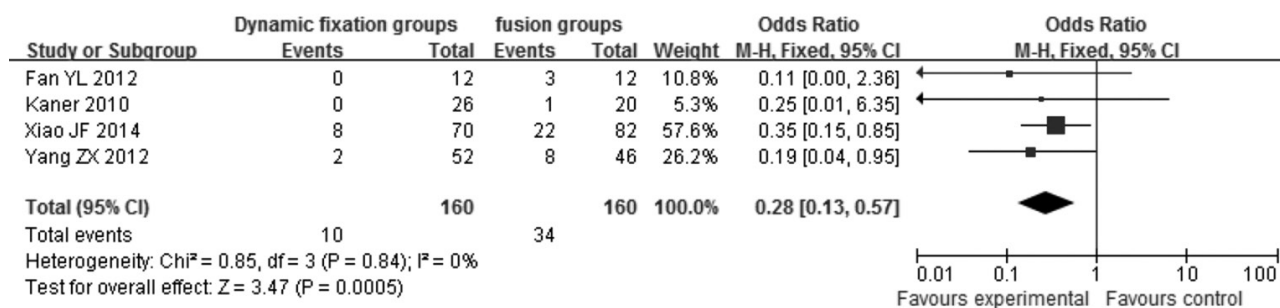


Fig. 12. — Results of the meta-analysis of ASD between dynamic fixation and fusion groups.

as the operated segment, which was elucidated by Yang B et al. (33,35). The mean ROM of the operated segments decreased significantly compared with the preoperation ROM in the fusion groups during follow-up, whereas no significant changes were observed in the dynamic fixation groups during the short-term (MD, 2.97; 95% CI, -0.39 to 6.33 ; P = 0.08) or medium-term (MD, 1.85 95%CI, -2.46 to 6.16 ; P = 0.40) (Fig. 13) follow-up. Sensitivity analysis was performed and the results was consistent with the above outcome because of high heterogeneity (P < 0.00001 ; I² = 96%). Moreover, six studies reported on the ROM in adjacent segment, four (2,7,16,33) of which measured the ROM of the cranial and caudal adjacent segments; the results showed that ROM of both the cranial (MD, -0.20 ; 95% CI, -0.84 to 0.45 ; P = 0.55) (Fig. 14) and caudal (MD, 0.22 ; 95% CI, -0.36 to 0.79; P = 0.46) (Fig. 15) adjacent segments displayed no significant change

compared with the ROM during preoperation in the dynamic fixation groups, as well as in the ROM of both the cranial (MD, -0.35 ; 95% CI, -2.34 to 1.63 ; P = 0.73) (Fig. 16) and caudal (MD, -0.01 ; 95% CI, -0.48 to 0.46 ; P = 0.97) (Fig. 17) adjacent segments in the fusion groups. Duing to significant heterogeneity (P = 0.0001 ; I² = 86%), sensitivity analysis confirmed the above outcome whereas subgroup analysis couldn't be performed because of too small samples. However, the groups patients who received dynamic instrumentation displayed a significant decrease in ROM of the caudal adjacent segment compared with the groups of patients who received fused instrumentation both at short-term (MD, 0.89 ; 95% CI, 0.07 to 1.71; P = 0.03) and medium-term (MD, -1.70 ; 95% CI, -2.29 to -1.10 ; P < 0.00001) follow-up (Fig. 18). Nevertheless, no significant difference (MD, 0.27 95% CI, -1.01 to 1.54 ; P = 0.68) (Fig. 19) was observed in ROM of the cranial adjacent segments in both groups.

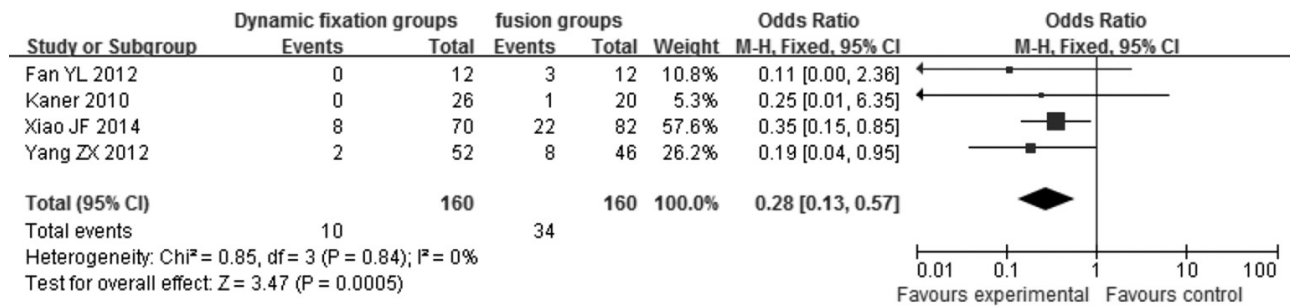


Fig. 13. — Results of the meta-analysis of the preoperation and postoperation ROM of the operated segments in the dynamic fixation groups.

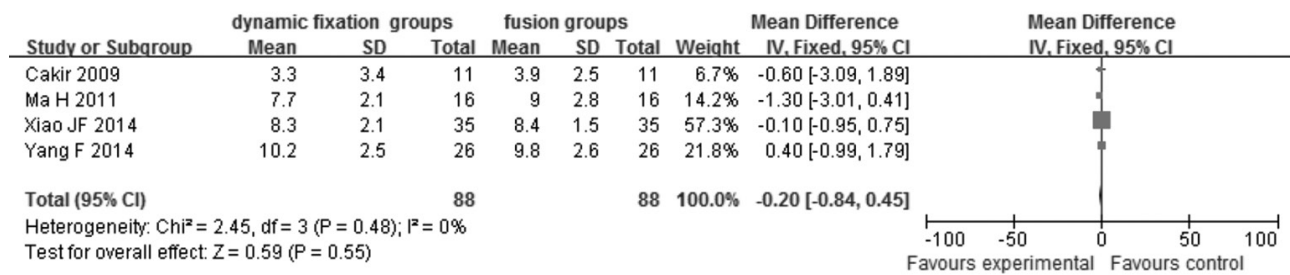


Fig. 14. — Results of the meta-analysis of the preoperation and postoperation ROM of cranial adjacent segments in the dynamic fixation group.

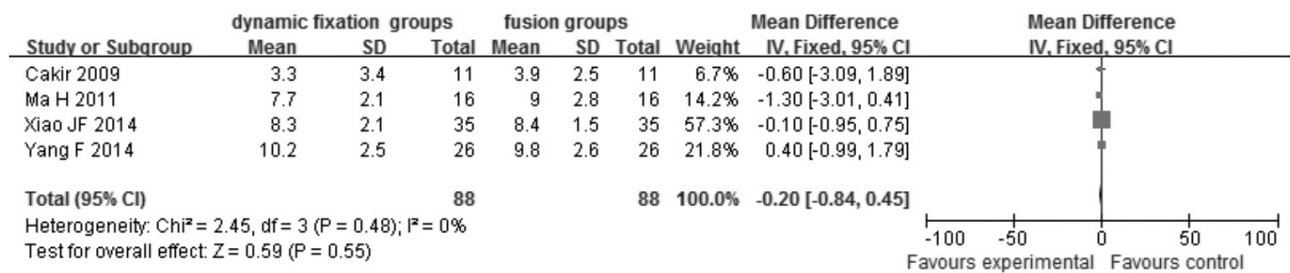


Fig. 15. — Results of the meta-analysis of the preoperation and postoperation ROM of caudal adjacent segments in the dynamic fixation group.

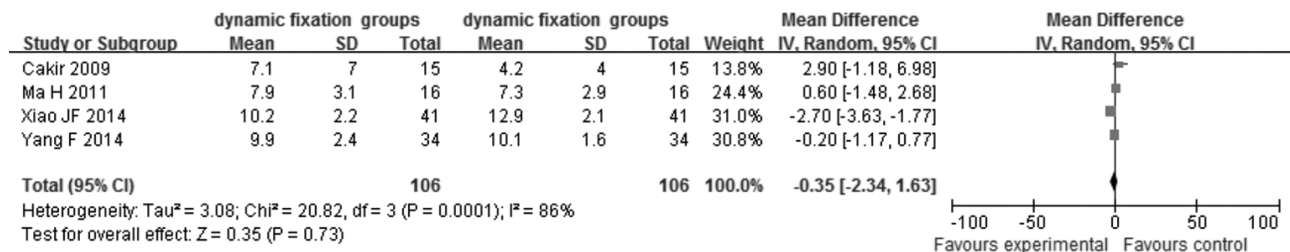


Fig. 16. — Results of the meta-analysis of the preoperation and postoperation ROM of cranial adjacent segments in the fusion groups.

DISCUSSION

Chronic LBP is currently a common health problem as a result of aging population; LDDD has been considered as the main cause of LBP (18). LDDD is often accompanied by abnormal load transmission and vertebral hypermobility; lumbar fusion, which can prevent the progression of hypermobility and maintain the stability of the spinal column, is the gold standard surgical treatment for LDDD and has been developed for several decades (31). However, along with the change in the original biomechanics of the spine, the loss of motion at the fused levels will accelerate the excessive motion of the adjacent nonfused segments (32). In addition, a series of complications, such as non-union, instrumentation failure, donor site pain and especially ASD, emerges gradually during the follow-up period (25). Various LPDSS have thus recently become alternative interventions to lumbar fusion to avoid the above disadvantages. LPDSS is superior in terms of unloading the disc/facet joints, in preserving motion under mechanical load and in restricting abnormal motion in the spinal segment (19). However, some problems have emerged during the follow-up period following the use of LPDSS. A few studies compared the two surgical methods for LDDD treatment but no consensus was achieved. This meta-analysis was thus performed to comprehensively evaluate the safety, effectiveness and radiological changes in the two surgical approaches. A total of 16 studies were included in this meta-analysis. Kaner et al. (12), along with the other studies, found that dynamic fixation offers advantages in terms of safety and rapid operation and that the patients displayed reduced intra-operative blood loss, hospital stay and complications during follow-up. The pooled results of this meta-analysis are consistent with the conclusion of the above studies, so we concluded based on the above results that LPDSS is safer than lumbar fusion for LDDD treatment. Moreover, qualitative analysis revealed a strong evidence for the significantly improved function (ODI score) and pain status (VAS score) in both groups compared with preoperative status. However, we found that the groups treated with dynamic fixation did not

display a more obvious relief in the postoperative pain status (VAS score) compared with that in the fusion groups during follow-up. Some studies separately investigated the back and leg VAS scores, and the statistical results confirmed the above conclusion. For the postoperative functional status restoration (ODI score), the outcome indicated that the patients treated with dynamic fixation showed greater degree of improvement in terms of ODI compared with those in the fusion groups, although no significant difference was observed in the postoperative ODI score between the two groups at short-term or medium-term follow-up. Moreover, most patients of the two groups were satisfied with the two surgical interventions without obvious difference; thus, the above results strongly demonstrated that the two surgical interventions were both effective for LDDD treatment, and no obvious statistical difference between these groups was observed, except for the greater degree of ODI improvement in the dynamic fixation groups.

Changes in ROM and biomechanical stresses at adjacent levels in a fusion site have been subjects of intensive research and controversial debate for decades. Some scholars proposed that the fusion of operated levels may lead to hypermobility of the adjacent levels, to changes in biomechanical stresses, as well as in ASD. Animal studies have provided some evidence for ASD and thus confirmed the above assumption (24,26). To avoid hypermobility and changes in biomechanical stresses at adjacent levels, researchers have recently applied LPDSS, which can potentially eliminate the drawback of lumbar fusion. In this meta-analysis, only four studies provided relevant data, and the results showed that the patients treated with LPDSS displayed obviously low rate of ASD (OR, 0.28; 95% CI, 0.13 to 0.57; $P = 0.0005$) than those in the fusion groups during follow-up. We thus inferred based on the above statistical result that LPDSS may reduce ASD.

Shono et al. (30) found that hypermobility at the adjacent levels is proportional to the length and rigidity of the instrumented constructs. Several *in vitro* experiments (4,6,10,21,27,28) using both human and animal specimens detected hypermobility at operated and adjacent levels of a fusion site. We

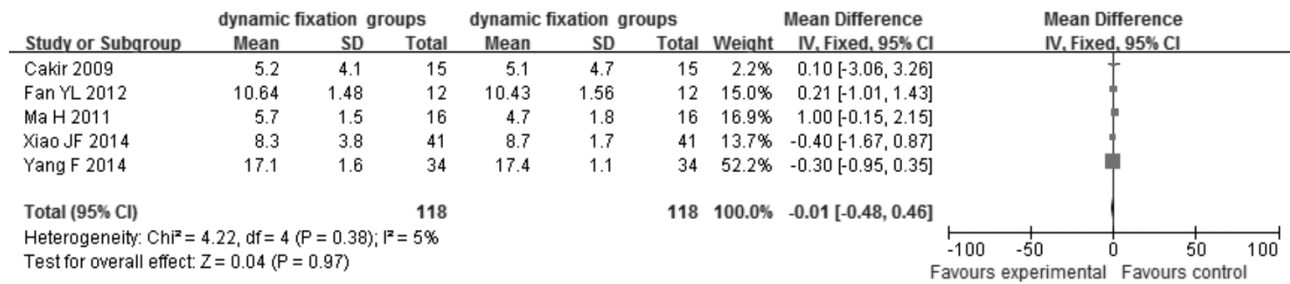


Fig. 17. — Results of the meta-analysis of the preoperation and postoperation ROM of caudal adjacent segments in the fusion groups

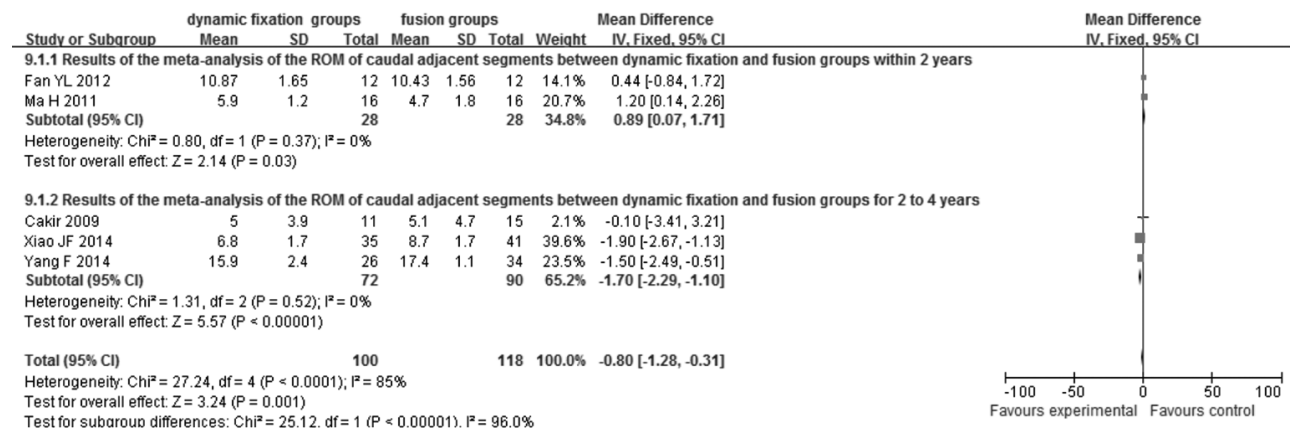


Fig. 18. — Results of the meta-analysis of the ROM of caudal adjacent segments between dynamic fixation and fusion groups

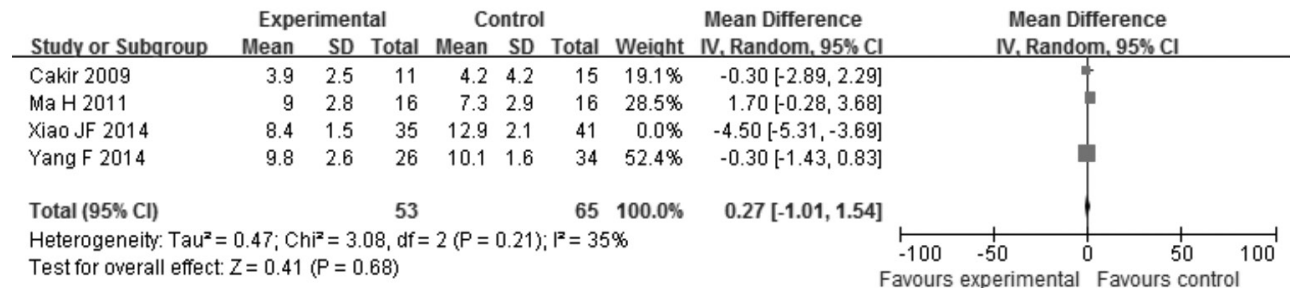


Fig. 19. — Results of the meta-analysis on ROM of cranial adjacent segments in the dynamic fixation and fusion groups

thus inferred from the results of these animal and cadaver experiments that the patients treated with lumbar fusion may experience similar problems and that LPDSS is an alternative intervention to avoid the above disadvantages. Few trials have compared the ROM of the operated and adjacent segments, and they reported varied results; hence, this meta-analysis was performed and found

that the mean ROM of the operated segments, compared with that at pre-operation, decreased significantly in the fusion groups but not in the dynamic fixation groups. Moreover, six studies reported the ROM in adjacent segment, and four of them measured the ROM of the cranial and caudal adjacent segments. The results showed that the preoperation and postoperation ROM of both

the cranial and caudal adjacent segments in both the dynamic fixation and fusion groups are not significantly different. However, groups of fused instrumented patients with a significant increase in caudal adjacent segments ROM compared with groups of dynamically instrumented patients except for cranial adjacent. Unfortunately, the conclusion of this paper may differ from the previous assumption that the ROM of the adjacent segment is greater in the fusion groups than in the dynamic fixation groups. We inferred that this disparity in conclusion may be caused by some reasons. Firstly, the sample size was considerably small, where only four studies were included in this paper. Secondly, the different types of LPDSS and lumbar fusion may have influenced the outcome. In addition, the included articles did not include long-term follow-up, which may be another reason for the incongruence.

Meta-analysis is an effective method to resolve a wide variety of clinical questions by summarising and reviewing published quantitative studies. However, several potential shortcomings may affect the conclusions of meta-analyses. Firstly, different procedures for fusion and different types of LPDSS may affect the comparison between the interventions, although no LPDSS device is superior or inferior relative to the others. In addition, the follow-up period varied because of conditional restrictions. The homogeneous quality of the included article may also further affect the conclusion. Finally, the measurement error in different studies is possibly another factor influencing the outcome. Thus, the results of this meta-analysis should be cautiously accepted.

CONCLUSION

LPDSS is significantly safer and is accounted for fewer complications than lumbar fusion. LDPSS-treated patients showed reduced hospital stay, ASD, and ROM of the caudal adjacent segment. These patients also exhibited a greater degree of improvement in ODI during follow-up than fusion-treated patients. Our results suggested that LPDSS may be a good option for the treatment of LDDD in the current follow-up period. However, outcomes of long-term follow-up remain uncertain.

Thus, a prudent attitude is necessary to select between the two interventions that can be applied to large-scale and long-term follow-up studies.

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