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Original Article

Decompression alone can improve the symptoms of lumbar spinal stenosis. A large sample meta-analysis

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Abstract: Background: Decompression alone or decompression with fusion, which one is more suitable for spinal stenosis has no consensus until now. The aim of this study is to compare decompression alone with fusion in multiple perspectives. Methods: A literature search was performed in PubMed, Web of Science, Embase and Cochrane Library. A total of 28 articles including 189572 patients were brought into this Meta-analysis finally. The outcomes were divided into primary ones and secondary ones. Subgroup analysis was performed in those articles which excluded patients with spinal instability or spondylolisthesis. Meanwhile, high quality articles were used to sensitivity analysis and publication bias was also evaluated by funnel plot. Results: Decompression without fusion led to less blood loss (P<0.001), shorter hospital stay (P<0.001), lower hospital charges (P<0.001) and shorter operation time (P<0.001). In the case of postoperative complication (P<0.001), readmission (P<0.001) and mortality (P<0.001), decompression alone also did much better. There were no significant differences in postoperative VAS score, ODI sore and pain management between these two groups. However, patients in fusion group felt more content than those in decompression group (P=0.004). As for sensitivity analysis, there are nearly no changes in any outcomes, except for satisfaction in two groups was not different. No obvious changes appeared in subgroup analysis. Conclusion: Decompression alone can provide better surgical outcomes for spinal stenosis, especially in old patients without spinal instability and spondylolisthesis. The extra fusion may leads to more complications.

Keywords: Meta-analysis, spinal stenosis, spondylolisthesis, decompression alone, fusion

Introduction

Developments in modern medicine have significantly increased life expectancy, and the resulting population aging means that orthopedists are being increasingly confronted with older patients suffering from lumbar spinal stenosis caused by degenerative changes of the lumbar spine. Surgery should be considered when conservative therapy fails to improve the symptoms of lumbar spinal stenosis [1]. Lumbar spinal stenosis (LSS) is the most common indication for spine surgery in patients older than 65 and its prevalence is expected to rise 59% to 64 million elderly adults by the year 2025 [2, 3]. Cost to Medicare for inpatient Lumbar spinal stenosis surgery is higher than diabetes and comparable with cardiovascular disease [4]. Surgery for the treatment of lumbar spinal stenosis typically involves a laminectomy with or without fusion, and has been the fastest growing indication for lumbar surgery. Thus far, there are little consensus on the indication for spinal imaging or the specific procedure, containing decompression and decompression with fusion, to perform on spinal stenosis [5].

Various studies have been performed seeking to examine the optimal surgical treatment for spinal stenosis. Biomechanical studies have shown a correlation between the extent of decompression and post-operative instability. Decompression without fusion may lead to spondylolisthesis or iatrogenic instability [3, 6, 7]. Some patients who underwent decompression alone complained of recurring pain soon after surgery and needed to later undergo fusion surgery [8]. However, fusion procedures are associated with an increased risk of complications, 30-day mortality, and resource use [5,

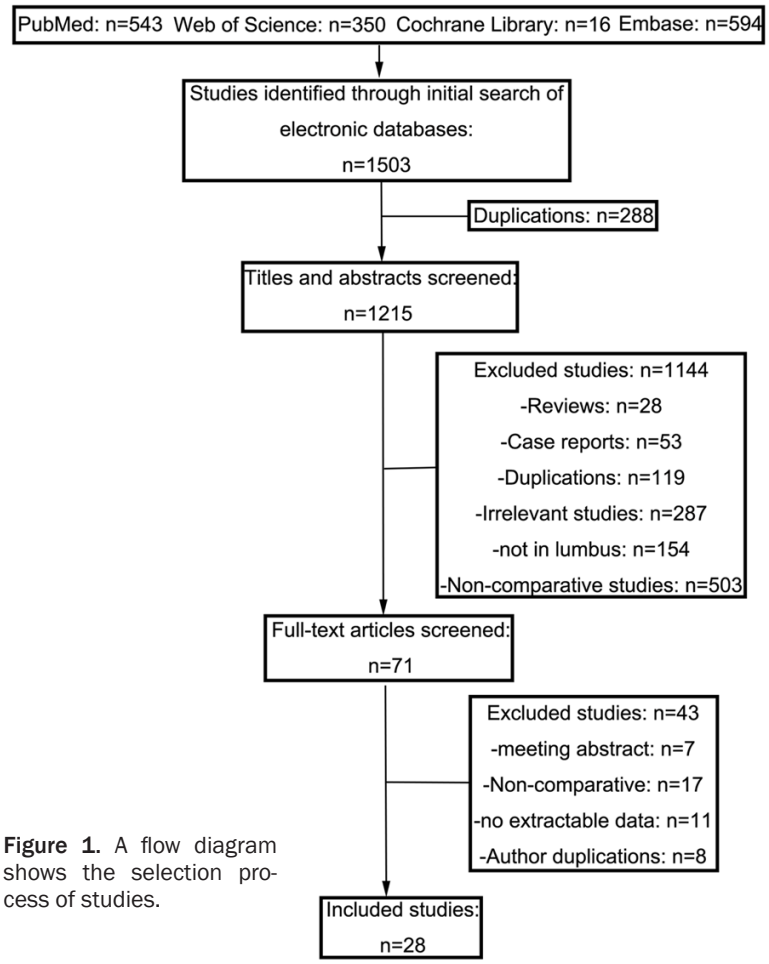

Figure 1. A flow diagram shows the selection process of studies.

9-11], and it may also increase reoperation rates due to the development of adjacent segment disease [5, 12, 13], which receives extensive concern. Many studies have compared the clinical outcomes between decompression with and without fusion for spinal stenosis in elderly patients [8]. Nevertheless, the outcomes are conflicting.

Therefore, the aim of our study is to compare the clinical outcomes between decompression with and without fusion, and provide an optimal therapy for spinal stenosis, especially in old patients.

Materials and methods

Search strategy and criteria

A literature search using PubMed, Embase, Web of Science and Cochrane Library was performed in January 2016 without restriction to time, publication types, or languages. Key words included spinal stenosis AND decompression alone (OR simple decompression, OR laminotomy, OR Laminectomy) AND fusion (OR arthrodesis OR spondylo*). The references of selected articles were also manual checked to find out if they were related.

Inclusion/exclusion criteria

The articles met the following criteria were used: 1) Lumbar spinal stenosis; 2) Randomized Controlled Trial and comparative studies, which compared decompression alone with fusion; 3) Studies must had data that we were interested in and can be extracted. Studies were excluded if: 1) The stenosis was caused by relapse, trauma, cancer, heredity, or cysts and so on but not degeneration; 2) The articles type are review or Meta-analysis; 3) Those papers which submitted by the same author or similar department and the patients they were analyzed were alike.

Data management

Data from these selected articles were independently extracted by two authors who were both blinded to the writers, the institutions and the journals of each article, and each disagreement were solved by the senior author.

We divided the outcomes into primary ones and secondary ones. The primary outcomes contained postoperative complications, readmission, mortality, postoperative pain, pain management and patient satisfaction. Postoperative back and leg pain was measured by visual analog scale (VAS) scores separately. Pain management included analgesic taken and injected.

The secondary outcomes included hospital stay, mean blood loss, medial operation time and hospital charges. We only compared the money spent at the first inpatient time, and the

Table 1. characteristics of included studies are showed below

Study	Level of evidence	Patients No.		Follow up	Age (y)	Stability	Matching*	Spondylolisthesis*	Quality score
		Dep*	Fusion*						
Munting et al.	2b	1068	108	1 year	Mea*68	NA*	1, 3, 4, 5, 6	W/O*	★★★★★★★★
Kim et al.	2b	25	30	1 year	40-80	W*	1, 2, 3, 4, 5, 6, 7	W/O	★★★★★★★★
Ghasemi et al.	4	39	31	14 months	Mea 54	NA	1	NA	★★★★★
Shivanand et al.	4	2385	620	5 years	Mor 18	W	2, 3	W/O	★★★★★
Forsth et al.	2b	4259	1131	2 years	Mor 50	NA	1, 4, 5, 6	W	★★★★★★★★
Richard et al.	2b	10291	1728	30 days	NA	NA	N*	NA	★★★★★★
Modhia et al.	2b	4164	629	3 years	Les 85	NA	3, 4	W/O	★★★★★★★
Seong et al.	2b	31	29	5 years	65-85	W	1, 2, 3, 4, 6, 7	W/O	★★★★★★★
Richard et al.	2b	76520	16955	2 years	Mor 65	W	2, 3	W/O	★★★★★★
Hyun et al.	4	47008	20829	NA	NA	NA	3,	W	★★★★★
Chang et al.	2b	25	25	2 years	Mor 75	W	1, 2, 3, 4, 6, 7	W/O	★★★★★★★
Zhang et al.	4	18	56	1 years	52-89	W/O	N	W	★★★★
Paik et al.	2b	15	17	1 year	Mea 59	NA	1, 5, 6, 7	NA	★★★★★★
Mahadewa et al.	4	46	59	20 months	Mea 50	W/O	1, 5, 6, 7	W	★★★★★
Chen et al.	4	106	39	5 years	NA	W/O	1	NA	★★★★★
Xu wx et al.	4	46	22	5 years	32-78	NA	N	NA	★★★★
Ghogawala et al.	4	20	14	1 year	Mea 69	NA	1, 3	W/O	★★★★★
Hallett et al.	RCT	14	30	5 years	34-75	W/O	1, 3, 4	W/O	RCT
Athiviraham et al.	4	54	42	2 years	Mea 63	NA	4,	W	★★★★★
Trouillier et al.	4	36	43	72 months	Mea 62	W/O	1	W/O	★★★★
Cornefjord et al.	2b	37	59	7 years	29-87	NA	1, 2, 4	W	★★★★★★★
Rompe et al.	2b	90	27	8 years	45-86	NA	1, 4, 5, 6, 7	W	★★★★★★
Kazunori et al.	2b	41	19	2 years	32-79	W/O	1, 3	W/O	★★★★★★
Kalbarczyk et al.	4	152	9	3 months	Mor 70	W/O	N	NA	★★★★
Jeffrey et al.	2b	194	78	2 years	Mea 69	NA	1, 5, 6, 7	W	★★★★★★★
Alexander et al.	4	25	25	3 years	NA	NA	1, 3, 4	NA	★★★★★
Mark et al.	4	92	32	6 years	Mea 68	NA	N	NA	★★★★★
Sung et al.	2b	47	38	3 years	Mea 56	NA	1, 4, 5, 6	NA	★★★★★★★

Dep = Decompression alone; Fusion = decompression and fusion. Spondylolisthesis: less than Grade I, we defined as without Spondylolisthesis; W = with; W/O = without; N = unmatched; Mor = more than; Less = less than; Mea = mean; NA = data not available. Matcing: 1 = age; 2 = stability; 3 = Spondylolisthesis; 4 = numbers of level; 5 = preoperative VAS for back pain; 6 = preoperative VAS for leg pain; 7 = preoperative ODI score.

money spent for rehabilitation or nutrition after discharging from the hospital was not brought into analysis.

Quality assessment and statistical analysis

The methodological quality of RCTs was assessed by the Cochrane risk of bias tool [14] which included selection bias, performance bias, detection bias, attrition bias and reporting bias. The methodological quality of retrospective studies was assessed by the modified Newcastle-Ottawa scale (NOS), which consists of three factors: patient selection, comparability of the study groups, and assessment of outcome [14, 15]. The total scores are 9. We defined low bias RCTs and these articles which achieved more than 6 scores as high quality articles.

The Cochrane Collaboration's Review Manager was used to pool the data. Mean difference and 95% CIs were calculated to pool the functional outcome [14, 16-18]. Significances were tested by using the Student's t-test, in which $P<0.05$ was considered significant. Statistical heterogeneity between studies was assessed by using the chi-square test with significance set at $P<0.1$, and heterogeneity was quantified using the I^2 statistic. The random-effects model was used if there is heterogeneity ($I^2>50\%$) between studies; otherwise, the fixed-effects model was used [14, 15].

Sensitivity analyses were performed for high quality studies. Funnel plots were used to screen for potential publication bias [15, 19]. We also compared decompression alone with fusion in those patients without spinal instability and Spondylolisthesis.

Table 2. Qualities of including articles are evaluated by modified Newcastle-Ottawa scale

Study	Selection				Comparability		Outcomes		Quality score
	Case definition	Represen-tativeness	Selection of Controls	Definition of Controls	Comparable for 1 2 3 4*	Comparable for 5 6 7*	Assessment of outcome	Integrity of follow-up	
Munting et al.	Yes	Yes	Yes	Yes	1, 3, 4	5, 6	Yes	Yes	★★★★★★★★
Kim et al.	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	★★★★★★★
Ghasemi et al.	Yes	No	Yes	Yes	1	No	Yes	Yes	★★★★★
Shivanand et al.	Yes	Yes	Yes	No	2, 3	No	Yes	No	★★★★★
Forsth et al.	Yes	Yes	Yes	Yes	1, 4	5, 6	Yes	Yes	★★★★★★★★
Richard et al.	Yes	Yes	Yes	Yes	No	No	Yes	Yes	★★★★★★
Modhia et al.	Yes	Yes	Yes	Yes	3, 4	No	Yes	Yes	★★★★★★★
Seong et al.	Yes	No	Yes	Yes	Yes	6, 7	Yes	Yes	★★★★★★★
Richard et al.	Yes	Yes	Yes	Yes	2, 3	No	Yes	No	★★★★★★
Hyun et al.	Yes	Yes	Yes	Yes	3	No	Yes	No	★★★★★
Chang et al.	Yes	No	Yes	Yes	Yes	6, 7	Yes	Yes	★★★★★★★
Zhang et al.	Yes	No	Yes	Yes	No	No	Yes	No	★★★★
Paik et al.	Yes	No	Yes	Yes	1	Yes	Yes	Yes	★★★★★★
Mahadewa et al.	Yes	No	Yes	No	1	Yes	Yes	Yes	★★★★★
Chen et al.	Yes	No	Yes	Yes	1	No	Yes	Yes	★★★★★
Xu et al.	Yes	No	Yes	No	No	No	Yes	Yes	★★★★
Ghogawala et al.	Yes	No	Yes	Yes	1, 3	No	Yes	Yes	★★★★★
Hallett et al.									RCT
Athiviraham et al.	Yes	No	Yes	Yes	4	No	Yes	Yes	★★★★★
Trouillier et al.	Yes	No	Yes	Yes	1	No	Yes	No	★★★★
Cornefjord et al.	Yes	No	Yes	Yes	1, 2, 4	Yes	Yes	Yes	★★★★★★★
Rompe et al.	Yes	No	Yes	Yes	1, 4	Yes	Yes	No	★★★★★★
Kazunori et al.	Yes	No	Yes	Yes	1, 3	No	Yes	Yes	★★★★★★
Kalbarczyk et al.	Yes	No	Yes	No	No	No	Yes	Yes	★★★★
Jeffrey et al.	Yes	Yes	Yes	Yes	1	Yes	Yes	Yes	★★★★★★★
Alexander et al.	Yes	No	Yes	No	1, 3, 4	No	Yes	Yes	★★★★★
Mark et al.	Yes	No	Yes	Yes	No	No	Yes	Yes	★★★★★
Moon et al.	Yes	No	Yes	Yes	1, 4	5, 6	Yes	Yes	★★★★★★★

Matcing: 1 = age; 2 = stability; 3 = Spondylolisthesis; 4 = numbers of level; 5 = preoperative VAS for back pain; 6 = preoperative VAS for leg pain; 7 = preoperative ODI score.

Table 3. The results of comparison of decompression alone and decompression with fusion are showed below

Outcomes of interest	Study No.	Dep* patient no.	Fusion* patient no.	WMD/OR* (95% CI*)	*p* value	Study heterogeneity			
						x^2	df	I^2, %	*p* value*
Primary outcomes									
Post*VAS score for bake pain	6	5607	1461	1.30 (-3.47, 6.08)	0.59	28.45	5	82	<0.01
Post*VAS score for leg pain	5	5413	1383	3.59 (-3.69, 10.87)	0.33	42.34	4	91	<0.01
Pain management	4	8473	1849	1.05 (0.79, 1.38)	0.75	7.04	3	57	0.07
Post*ODI score	7	4500	1361	1.96 (-0.15, 4.07)	0.07	53.44	6	89	<0.01
Satisfaction	13	878	429	0.64 (0.48, 0.87)	0.004	14.95	12	20	0.24
Complications	11	90415	22243	0.55 (0.47, 0.66)	<0.05	20.89	10	52	0.02
Readmission	13	49104	10014	0.88 (0.82, 0.95)	<0.05	15.66	12	23	0.21
Mortality	3	133819	35512	0.62 (0.43, 0.89)	<0.05	5.68	2	65	0.06
Secondary outcomes									
Hospital stay [days]	5	80107	20357	-1.88 (-2.42, -1.33)	<0.05	120.46	4	97	<0.01
blood loss [ml]	3	151	98	-530.5 (-813, -248)	<0.05	40.5	2	95	<0.01
Operation time [h]	4	241	125	-1.97 (-2.87, -1.06)	<0.05	60.1	3	95	<0.01
Hospital charges [dollars]	3	79895	20255	-1.41 (-2.09, -0.74)	<0.05	292.51	2	99	<0.01

Dep = Decompression alone; Fusion = Decompression and fusion; WMD/OR = weight mean difference/odds ratio; CI = confidence interval df = degrees of freedom; Post = postoperative.

Results

Search result

A literature search found 1503 (543 articles from PubMed, 350 from Web of Science, 16 articles from Cochrane Library, and 594 articles from Embase) potentially relevant articles (**Figure 1**). After two reviewers browsed titles and abstracts of these studies independently, only 71 studies were left for full-article review. Finally, a total of 28 articles, including one RCT and 27 comparative studies, which met our requirement were brought into this Meta-analysis.

The basic characteristics of included articles were showed in **Table 1**, and the quality of comparative studies which was evaluated by modified NOS was showed in **Table 2**. There were one small sample RCTs [18], 14 high quality retrospective studies [5, 7, 8, 10, 26, 27, 29, 35-37, 40, 41, 43, 47], and 13 relatively low quality retrospective articles [2, 3, 12, 14, 16, 20, 25, 28, 32, 44, 46, 48, 49] in this Meta-analysis.

Primary outcomes

Six studies described VAS scores for back pain and leg pain, and showed no significant differences between these two groups in both VAS scores for back pain (WMD: 1.30, 95% CI: -3.47~6.08, P=0.47) and leg pain (WMD: 3.59, 95% CI: -3.69~10.87, P=0.33) (**Table 3**). Meanwhile, the pooled data of other four articles including 10322 patients showed no significant differences about analgesic requirement (OR: 1.05, 95% CI: 0.79-1.38, P=0.75), and ODI scores were also similar in both groups (WMD: 1.96, 95% CI: -0.15~4.07, P=0.07). Satisfaction was reported by 13 articles, which indicated that patients in the fusion group were more satisfied with the outcomes (OR: 0.64, 95% CI: 0.48~0.87, P=0.004). However, the outcome was similar when we did the subgroup analysis of the satisfaction (OR: 0.85, 95% CI: 0.55~1.31, P=0.47) (**Figure 2**). 11 studies containing 112658 patients reported the postoperative complications. Comparing with fusion, decompression alone led to fewer surgical complications rate (OR: 0.55, 95% CI: 0.47~0.66, P<0.001). The readmission rate was higher in the fusion group, which was reported by 13 articles (OR: 0.88, 95% CI: 0.82~0.95, P<0.001). Three articles including 133819 patients showed that the mortality was higher in fusion group (OR: 0.62, 95% CI: 0.43~0.89, P<0.001).

Secondary outcomes

Comparing with fusion, decompression alone can provide shorter hospital stay (WMD: -1.88, 95% CI: -2.42~-1.33, P<0.001), less blood loss

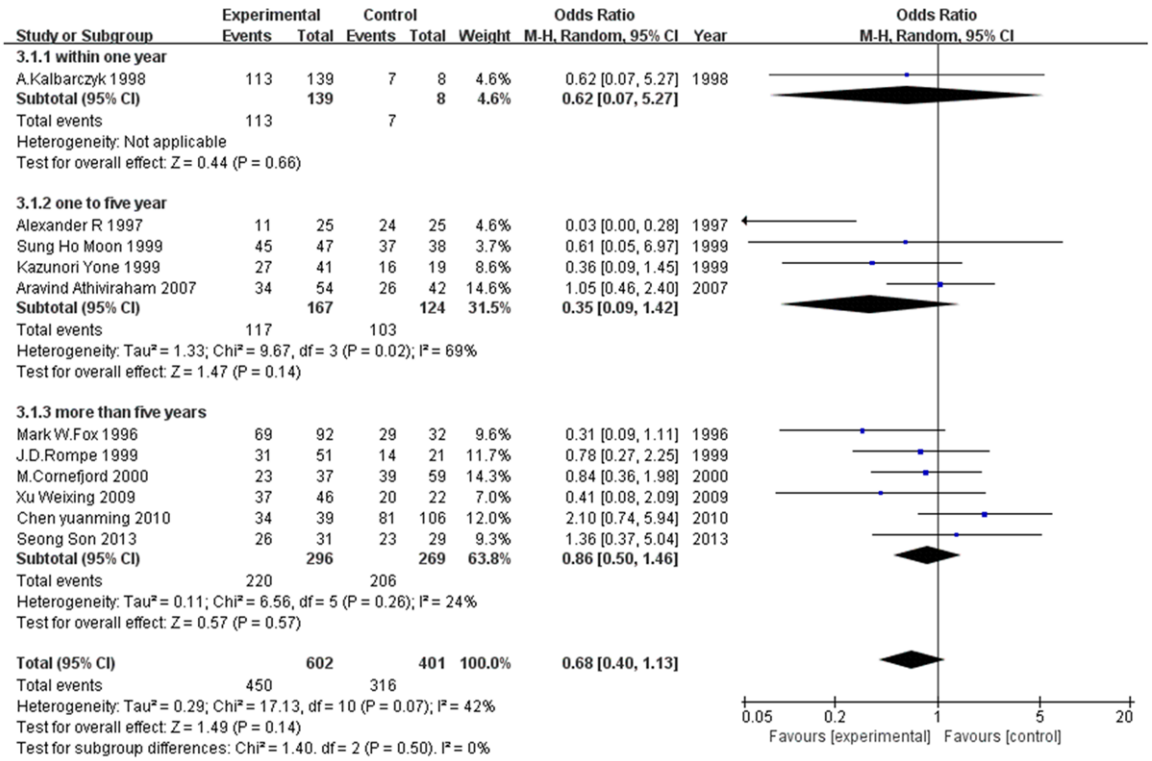

Figure 2. Sub group of forest plot shows the comparison of satisfaction at long-term follow-up (more than 5 years).

Table 4. Sensitivity analysis comparison of decompression alone and decompression with fusion shows below

Outcomes of interest	Study No.	Dep* patient No.	Fusion* patient No.	WMD/OR* (95% CI*)	*p* value	Study heterogeneity			
						x^2	df	I^2, %	*p* value*
Primary outcomes									
Post*VAS score for bake pain	5	5589	1405	-0.65 (-5.50, 4.20)	0.79	21.13	4	81	<0.01
Post*VAS score for leg pain	4	5395	1327	5.09 (-3.33, 13.51)	0.24	41.5	3	93	<0.01
Pain management	4	8473	1849	1.05 (0.79, 1.38)	0.75	7.04	3	57	<0.01
Post*ODI score	4	4330	1207	0.00 (-0.02, 0.02)	0.9	0.59	3	0	0.9
Satisfication	7	416	261	0.83 (0.56, 1.21)	0.33	2.68	6	0	0.85
Postoperative complications	4	86879	18771	0.48 (0.42, 0.56)	<0.05	5.37	3	44	0.15
Readmission	9	46549	9299	0.86 (0.80, 0.92)	<0.05	10.11	8	21	0.26
Mortality	2	86811	18683	0.52 (0.42, 0.64)	<0.05	0	1	0	0.95
Secondary outcomes									
Hospital stay [days]	3	76745	17062	-2.40 (-4.05, -0.76)	<0.05	7.92	2	75	0.02
blood loss [ml]	2	45	59	-820 (-1577.6, -62.4)	<0.05	13.2	1	92	<0.01
Operation time [hours]	3	135	86	-2.25 (-3.57, -0.92)	<0.05	55.15	2	96	<0.01
Hospital charges [dollars]	2	76639	16999	-0.99 (-1.85, -0.13)	<0.05	44.33	1	98	<0.01

Dep = Decompression alone; Fusion = Decompression and fusion; MD/OR = mean difference/odds ratio; CI = confidence interval; df = degrees of freedom; Post = postoperative.

(WMD: -530.5, 95% CI: -813~-248, P<0.001), shorter operation time (WMD: 1.97, 95% CI: -2.87~-1.06, P<0.05), and fewer hospital charges (WMD: -1.41, 95% CI: -2.09~-0.74, P<0.001).

Sensitivity analysis and publication bias

One RCT and 14 high quality retrospective articles which were evaluated by modified New-

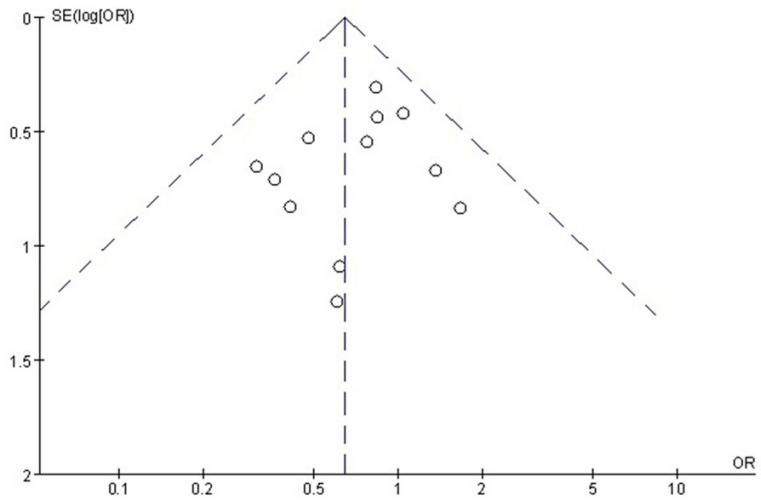

Figure 3. Funnel plot which was illustrated by satisfaction rate shows the publication bias. SE = standard error, OR = odds ratio.

castle-Ottawa scale were brought into sensitivity analysis (**Table 4**). Except for the satisfaction (OR: 0.76, 95% CI: 0.45~1.29, P=0.31), which showed no statistical differences between two groups, other indexes were all similar to the original outcomes. Meanwhile, the heterogeneity in primary outcomes were general lower in sensitivity analysis. But as for the secondary outcomes, there are no evident change of the heterogeneity.

The publication bias (**Figure 3**) was evaluated by the funnel plot containing 11 studies which described patient satisfaction. From the picture, we can find that all articles lie inside the 95% confidence interval and the distribution was symmetrical, which indicated no obvious publication.

Exclude articles referring to spinal instability or spondylolisthesis

After excluding the articles which contained patients with spinal instability or high grade spondylolisthesis (more than Grade II), the outcomes were still similar to the original ones (**Table 5**). Nonetheless, due to the data limitation of remanent articles, mortality, VAS scores for bake pain and leg pain, satisfaction, blood loss, and operation time were descried by only one articles, so the study heterogeneity can not be calculated accurately.

Discussion

Decompression without fusion reduced the rate of complication compared with decompression with fusion. It was well known that fusion procedures had more complications than decompression without fusion [20-23]. The risks of cerebrospinal fluid leakage, deep infection, and epidural hematoma were increased naturally. Simultaneously, patients who underwent fusion needed more time to stay in bed, especially old patients, which caused dysfunction in respiratory system, urinary system and so on. The reason was perhaps that fusion surgical procedures were more complex involving extensive tissue dissection, insertion of implants, and longer operative times [5].

Meanwhile, Patients in decompression without fusion had lower rate of reoperation, the same as some studies' outcome. Inadequate decompression with fusion may cause recurrence of spinal stenosis at previously operated or adjacent levels [4, 24]. Fusion was performed in more than half (56%) of the readmissions, suggesting that a potential major cause of readmission is the development of a new instability. Excessive decompression is the main reason of the new instability [4, 24]. And the rate of reoperation in decompression without fusion can be reduced if we cautiously formulated the range of decompression during operation.

Satisfaction was described by 13 articles. The outcome showed that patients in fusion group were more content. But when we compared the satisfaction in those patients who were followed for more than five years, there were no significant differences between decompression alone and fusion. We noticed that the same outcome was also appeared in sensitivity analysis. Satisfaction was evaluated by patients' subject feeling, and the patient bias play an important role. So we needed a more authoritative and detailed scale to avoid these adverse influence factors.

Table 5. Subgroup analysis of comparison of decompression alone and fusion when exclude patients with spinal instability or spondylolithesis

Outcomes of interest	Study No.	Dep* patient No.	Fusion* patient No.	WMD/OR* (95% CI*)	*p* value	Study heterogeneity			
						x^2	df	I^2, %	*p* value*
Primary outcomes									
Post*VAS score for bake pain	1	31	29	-1 (-0.57, 3.57)	0.67	-	-	-	-
Post*VAS score for leg pain	1	31	29	-2 (-7.06, 3.06)	0.44	-	-	-	-
Post*ODI score	2	56	59	-0.63 (-4.76, 3.50)	0.77	0.09	1	0	0.77
Satisfication	1	31	29	1.36 (0.37, 5.04)	0.65	-	-	-	-
Postoperative complications	3	4140	1937	0.58 (0.45, 0.74)	<0.05	9.22	2	78	<0.01
Readmission	6	44459	9127	0.89 (0.82, 0.96)	0.73	11.6	5	57	<0.01
Mortality	1	76520	16955	0.52 (0.41, 0.66)	<0.05	-	-	-	-
Secondary outcomes									
Hospital stay [days]	3	79807	20240	-1.86 (-2.45, -1.28)	<0.05	120	2	97	<0.01
blood loss [ml]	1	31	29	-460 (-536.8, -383.3)	<0.05	-	-	-	-
Operation time [h]	1	31	29	-2.9 (-3.59, -2.21)	<0.05	-	-	-	-
Hospital charges [dollars]	2	79913	20211	-1.83 (-2.65, -1.02)	<0.05	247	1	100	<0.01

Dep = Decompression alone; Fusion = Decompression and fusion; WMD/OR = weight mean difference/odds ratio; CI = confidence interval; df = degrees of freedom; Post* = postoperative.

Furthermore, there were also no differences in improvement of back pain, leg pain, and ODI scores between two operative methods. This outcome was agreement with previous article [24]. Mortality should be very low in spinal stenosis surgery. However, old patients with cardiopulmonary diseases ran a relatively higher risk at surgery. Our result showed that patients in fusion group faced higher rate of mortality, although it is both very low in two groups.

Modern surgical treatment consists in a combination of both decompression and stabilizing procedures Degenerative spondylolisthesis has been considered to be the origin of spinal stenosis, and a single decompressive procedure would increase the risk of further instability [25]. Surgical treatment containing both decompression and stabilizing procedures was suggested in modern surgery, and more and more evidences supported the benefits of immediate fixation in these population [26]. So we excluded patients with spondylolisthesis (more than grade II) or instability in this article.

Besides that, fusion may also result in hardware failure, non-union, donor site pain and invasiveness causing more paravertebral soft tissues injury [1, 27]. In addition, fusion restricted motion of involved segments, especially in the level of L5/S1, and may lead to adjacent segment degeneration by increasing biomechanical stresses on adjacent segments, especially in two or more levels fusion [1, 28-30].

We also found that decompression without fusion provided better secondary outcomes, compared with fusion. These include shorter hospital stay, less blood loss, shorter operative time and fewer hospital charges. The reason was perhaps that the procedure of surgery in fusion group was complex resulting in worse secondary outcomes [24]. These advantages would also help decrease patient's cost in decompression without fusion group.

However, there were also some limitations in this article. Firstly, we only reviewed patients without spinal instability or spondylolisthesis. Which surgery was more suitable for those instable patients was not analyzed in this article. Secondly, there was only one small sample RCT and 14 high quality retrospective articles, other 13 studies' quality was low, and more RCTs were needed in further research. Thirdly, heterogeneity was a little high in some indexes, epically in secondary outcomes. Heterogeneity was not significant for dichotomous outcomes but was significant for most of the continuous variables. Studies including different countries, surgical indications, matching criteria, operative techniques, and measurement of outcomes might contribute to a high heterogeneity. Pooling of data with random-effects model

might reduce the effect of heterogeneity but does not abolish it.

Conclusion

When treated spinal stenosis, especially in old patients without spinal instability or high grade spondylolisthesis, decompression alone can provide better outcomes, and extra fusion can't improve the curative effect but may brought about more complications.

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Disclosure of conflict of interest

None.

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