

## Original Article

# Comparison of anterior cervical discectomy and fusion versus anterior cervical corpectomy and fusion for the treatment of contiguous two-level cervical spondylotic myelopathy

Rouziaji Kamilijiang, Atawula Wubulhasimu, Yuxin Zhang

*Department of Spinal Surgery, The First People's Hospital of Kashgar Prefecture, The Xinjiang Uyghur Autonomous Region, Xinjiang 844000, China*

Received March 12, 2016; Accepted October 31, 2016; Epub January 15, 2017; Published January 30, 2017

**Abstract:** Purpose: The purpose of this study is to evaluate the clinical effectiveness and safety of anterior cervical discectomy and fusion (ACDF) and anterior cervical corpectomy and fusion (ACCF) for treating contiguous two-level cervical spondylotic myelopathy (CSM). Methods: The authors searched electronic databases for relevant studies that compared the clinical effectiveness of ACDF and ACCF for the treatment of patients with contiguous two-level CSM. Data extraction and quality assessment were conducted, and RevMan 5.2 was used for data analysis. The random effects model was used if there was heterogeneity between studies; otherwise, the fixed effects model was used. Results: A total of six studies were included in our meta-analysis. No statistical difference was observed with regard to complications, degeneration of the level adjacent to the fusion, fusion rate, arm and neck VAS score, postoperative JOA score between ACCF and ACDF. Compared with ACDF group, the blood loss and operation time were significantly higher in the ACCF group, however, Cobb and fused segment height were significantly lower. Conclusions: Our meta-analysis reveals that surgical treatments of contiguous two-level CSM are similar in terms of most clinical outcomes using ACDF or ACCF. However, owing to the limitations of the current study, high-quality clinical studies with larger sample sizes are still needed to confirm our results.

**Keywords:** ACDF, ACCF, CSM

## Introduction

Cervical spondylotic myelopathy (CSM) is a clinically symptomatic condition caused by compression of the spinal cord due to degeneration. The degeneration of the intervertebral disc, uncovertebral joint, facet joint, posterior longitudinal ligament, and ligamentum flavum cause spinal cord compression and cervical myelopathy [1]. At present, patients diagnosed with symptomatic CSM were often recommended to receive anterior cervical decompression and fusion (ACDF) for patients diagnosed with CSM [2-5].

There are two representative surgical approaches for CSM: anterior and posterior. Anterior approaches usually involve ACDF or anterior cervical corpectomy with fusion (ACCF). ACDF is

a surgical procedure removing the intervertebral disc, replaced by a small plug of bone or other graft substitute, which usually applied for treating the compression of nerve root or spinal cord [6-8], while ACCF refers to a procedure removing part of the vertebra and adjacent intervertebral discs to decompress. Cervical spinal cord and nerves. ACDF and ACCF can establish a solid cervical stability that is conducive to relieving pressure on the level of compressed spinal cord. One recent meta-analysis by Huang Z-Y et al have shown that ACDF has more advantages compared to ACCF between the two surgeries to treat two-adjacent-level CSM [9]. Additionally, Guan L et al provided evidence that ACDF may be more effective than ACCF with respect to the operation time, blood loss as well as hospital time for CSM treatment [10]. However, Han YC et al reported that

## Comparison of ACDF versus ACCF for treating CSM

**Table 1.** Description of the assessment of validity and quality of articles according to Jadad et al [12]

Method	Assessment	Score*
Randomization	A method to generate the sequence of randomization will be regarded as appropriate if it allowed each study participant to have the same chance of receiving each intervention and the investigators could not predict which treatment was next.	1 point
	If the method to generate the sequence of randomization was described and it was appropriate (table of random numbers, computer generated, etc)	Add 1 point
	If the method to generate the sequence of randomization was described and it was inappropriate (patients were allocated alternately, or according to date of birth, date of admission, or hospital number, etc)	Deduct 1 point
Double blinding	A study must be regarded as double blind if the word "double blind" is used. The method will be regarded as appropriate if it is stated that neither the person doing the assessments nor the study participant could identify the intervention being assessed, or if in the absence of such a statement the use of active placebos, identical placebos, or dummies is mentioned	1 point
	If the method of double blinding was described and it was appropriate (identical placebo, active placebo, dummy, etc)	Add 1 point
	If the study was described as double blind, but the method of blinding was inappropriate (eg, comparison of tablet versus injection with no double dummy)	Deduct 1 point
Withdrawals and dropouts	Participants who were included in the study but did not complete the observation period or who were not included in the analysis must be described. The number and the reasons for withdrawal in each group must be stated. If there were no withdrawals, it should be stated in the article. If there is no statement on withdrawals, this item must be given no points	1 point
Total score		0-5 points

\*The minimum score is 0 (poor quality, significant flaws in design or conduct of trial); the maximum score is 5.

although complications and increased lordosis are significantly better in the ACDF group, there is no strong evidence to support the routine use of ACDF over ACCF in CSM [11].

At present, no standards or guidelines exist for the treatment of, contiguous two-level CSM. We performed a meta-analysis to evaluate the clinical outcomes between ACDF and ACCF for the treatment of CSM.

### Materials and methods

#### Search strategy and study selection

We searched for studies in electronic databases including PubMed (1966 to Dec 2015), MEDLINE (1966 to Dec 2015), EMBASE (1974 to Dec 2015), Cochrane Controlled Trial Register (Cochrane library 2015) and Google Scholar (1966 to Dec 2015). We restricted the language to English. The following search terms were used: (1) cervical spondylosis myelopathy OR CSM; (2) ACDF OR anterior cervical discectomy and fusion; (3) ACCF OR anterior cervical corpectomy and fusion. (1) and (2) or (3). Reference lists of all included studies were scanned to identify additional potentially relevant studies. Two reviewers independently screened the titles and abstracts of identified papers, and full text copies of all potentially relevant studies were obtained.

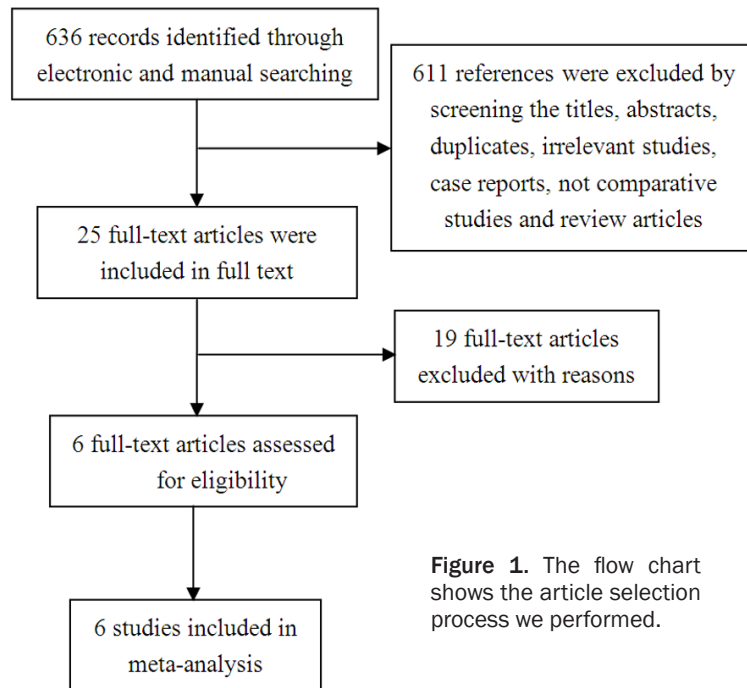
#### Inclusion criteria

All comparative studies that adopted ACCF and ACDF to treat two-adjacent-level cervical spondylosis were identified, and the reference lists of identified articles were searched to identify other potentially eligible studies. Studies were included if they met the following criteria: (1) ACCF with titanium mesh, cage or autologous ilium bone grafting; ACDF with inter body cage devices or autologous ilium bone grafting; and the two surgeries used anterior cervical plate and screw fixation. (2) All patients included had a confirmed CSM at two adjacent segments, and surgical intervention was recommended. (3) The trials were followed up for more than 12 months. Studies did not meet the above criteria were excluded from selection.

#### Exclusion criteria

(1) The studies did not meet the inclusion criteria. (2) The intraoperative outcome data (amount of bleeding and operation time), clinical outcomes (Japanese Orthopaedic Association (JOA) score and visual analogue scale (VAS) score for neck and arm pain), radiological outcomes (C2-C7 Cobb, fused segment height, fusion rate and degeneration of the adjacent level) or complications were not reported. (3) The number of samples was less than 30 cases. (4) The patients evaluated were treated at the same hospital.

## Comparison of ACDF versus ACCF for treating CSM



**Figure 1.** The flow chart shows the article selection process we performed.

and quantified by calculating  $I^2$  statistic, for which  $P < 0.1$  and  $I^2 > 50\%$  was considered to be statistically significant. For the pooled effects, weighted mean difference (WMD) or standard mean difference (SMD) was calculated for continuous variables according to the consistency of measurement units, and odds ratio (OR) was calculated for dichotomous variables. Continuous variables are presented as mean differences and 95% confidence intervals (CI), whereas dichotomous variables are presented as odds ratios and 95% CI. Random-effects or fixed-effects models were used depending on the heterogeneity of the studies included.

### Quality assessment of included studies

The 3-item scale of Jadad was used to assess the quality of included studies [12]. This instrument is referred to as the 'Jadad scale'. Scale scores can range from 0 to 5 points, with higher scores indicating better quality (Table 1).

### Data extraction

Two reviewers independently extracted the data using a standardised form, which covered the following items: (1) basic characteristics, including the year of publication, study design, inclusion/exclusion criteria, age, sex, enrolled number and follow-up rate; (2) intraoperative outcomes, consisting of operation time and amount of bleeding; (3) clinical outcomes, including Japanese Orthopaedic Association (JOA) score and visual analogue scale (VAS) score for neck and arm pain; (4) radiological outcomes, such as cervical lordosis for total cervical, fused segment height, segmental height, fusion rate, degeneration of the adjacent level and (5) complications, including short-term and long-term complications.

### Data analysis

We performed all meta-analyses with the Review Manager software (RevMan Version 5.2; (Cochrane Collaboration, Oxford, UK)). Heterogeneity was tested using Chi square test

### Results

The process of identifying relevant studies is summarized in Figure 1. From the selected databases, 636 references were obtained. By screening the titles and abstracts, 611 references were excluded due to duplicates, irrelevant studies, case reports, not comparative studies and review. The remaining 25 studies underwent a detailed and comprehensive evaluation. Finally, 6 studies were included in our meta-analysis [13-18]. Tables 2 and 3 summarise the baseline characteristics assessment and quality of included studies, respectively.

### Clinical outcome

**Operation time:** Two studies provided operation time at the last follow-up. Random-effect model was used as the pooling method. The operation time was significant higher in the ACCF group compared with the ACDF group [ $P = 0.03$ , WMD: 46.35 (4.00, 88.70); Figure 2].

**Blood loss:** Two studies provided blood loss at the last follow-up. Fixed-effect model was used as the pooling method. The blood loss was significant higher in the ACCF group compared with the ACDF group [ $P < 0.00001$ , WMD: 474.90 (411.92, 537.87); Figure 3].

## Comparison of ACDF versus ACCF for treating CSM

**Table 2.** Characteristics of included studies

Study ID	Design	Contry	Sample size	Age (years)	Follow up (months)
Burkhardt JK [13]	Retrospective	Switzerland	Total: 118	ACDF: 60.9±9.9	ACDF: N/A
			ACDF: 80 ACCF: 38	ACCF: 60.1±11.1	ACCF: 20.4±13.7
Jeffrey C [14]	Retrospective	USA	Total: 54	ACDF: N/A	ACDF: N/A
			ACDF: 32 ACCF: 20	ACCF: 51.5(17-80)	ACCF: 43.2 (24-84)
Liu J [15]	Retrospective	China	Total: 46	ACDF: 48.9 ± 9.4	ACDF: 84.5 ± 13
			ACDF: 22 ACCF: 24	ACCF: 51.8 ± 5.9	ACCF: 86 ± 11.5
Park Y [16]	Retrospective	South Korea	Total: 97	ACDF: 49.3±9.7	ACDF: 25.7±6.2
			ACDF: 45 ACCF: 52	ACCF: 49.4±8.7	ACCF: 23.3±6.6
Kim M [17]	Retrospective	Korea	Total: 70	ACDF: 56.7±10.2	ACDF: 18.6±11.5
			ACDF: 54 ACCF: 16	ACCF: 58±8.6	ACCF: 20±11.9
Oh MC [18]	RCT	Korea	Total: 31	ACDF: 52.64	ACDF: 24.9
			ACDF: 14 ACCF: 17	ACCF: 55.12	ACCF: 27.33

ACDF: anterior cervical discectomy with fusion ACCF: anterior cervical corpectomy with fusion N/A=not available.

**Table 3.** Quality assessment of included studies

Study (year)	Randomization	Double-blinding	Withdrawals/dropouts	Jadad Score
Burkhardt JK [13]	Appropriate	Not clear	Yes	3
Jeffrey C [14]	Inappropriate	Not clear	Yes	1
Liu J [15]	Inappropriate	Not clear	Yes	1
Park Y [16]	Inappropriate	Not clear	Yes	1
Kim M [17]	Not clear	Not clear	Yes	1
Oh MC [18]	Appropriate	Not clear	Yes	3

**Postoperative JOA score:** Two studies provided the postoperative JOA score at the last follow-up. Fixed-effect model was used as the pooling method. There was no significant difference between the two groups [P=0.15, WMD: -0.61 (-1.43, 0.22); **Figure 4**].

**Neck VAS:** Studies reported a postoperative neck VAS score. Fixed-effect model was used as the pooling method and the pooled data revealed no significant difference [P=0.95, WMD: -0.03 (-1.02, 0.95); **Figure 5**], with low heterogeneity (I<sup>2</sup>=6%).

**Arm VAS:** Two studies reported a postoperative arm VAS score. Fixed-effect model was used as the pooling method and the pooled data from the two relevant studies did not reveal any significant difference [P=0.14, WMD: -0.74 (-1.72, 0.24); **Figure 6**], with low heterogeneity (I<sup>2</sup>=0%).

**C2-C7 Cobb:** Four studies reported C2-C7 Cobb at the final follow-up. Fixed-effect model was used as the pooling method and the pooled

data from the four relevant studies revealed that ACCF group had a significantly lower Cobb than the ACDF group [P=0.002, WMD: -3.15 (-5.13, -1.17); **Figure 7**], with low heterogeneity (I<sup>2</sup>=38%).

**Fused segment height:** Two studies reported the fused segment height data at the final follow-up. Random-effect model was used as the pooling method. The pooled results

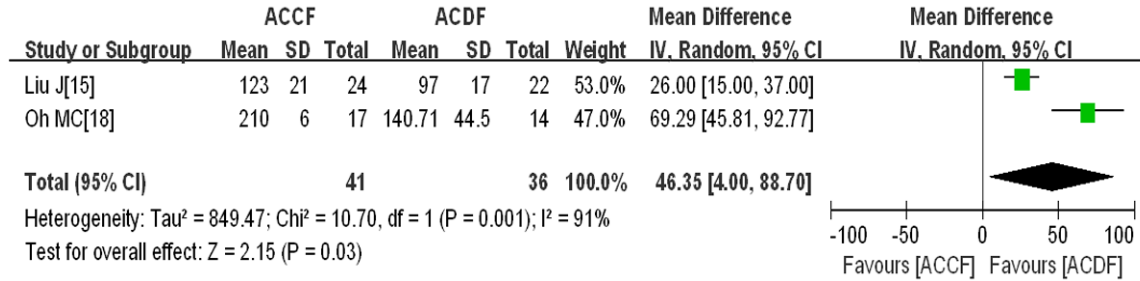
demonstrated that the ACCF group had a significantly lower fused segment height than the ACDF group [P=0.02, WMD: -3.73 (-6.96, -0.53); **Figure 8**].

**Fusion rate:** Four studies reported the fusion rate at the final follow-up. Fixed-effect model was used as the pooling method and the pooled results demonstrated that there was no significant difference in the fusion rate between the two groups [P=0.75, OR: 1.27 (0.29, 5.50); **Figure 9**], with low heterogeneity (I<sup>2</sup>=40%).

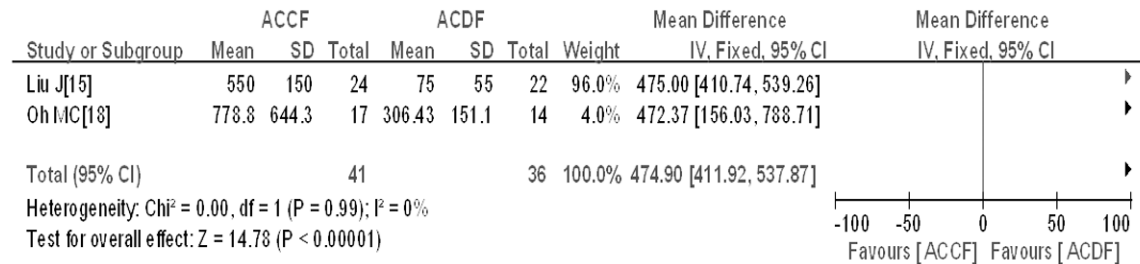
**Degeneration:** Two studies reported the degeneration of the level adjacent to the fusion at the final follow-up. Fixed-effect model was used as the pooling method and the pooled results revealed that there was no significant difference in the degeneration of the level adjacent to the fusion between the two groups [P=0.66, OR: 1.36 (0.36, 5.17); **Figure 10**], with no heterogeneity (I<sup>2</sup>=0%).

**Complications:** Five studies reported the complications at the final follow-up. Fixed-effect

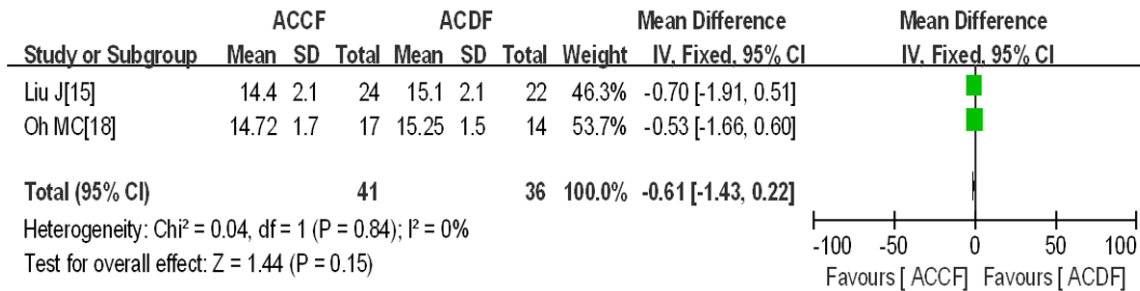
## Comparison of ACDF versus ACCF for treating CSM



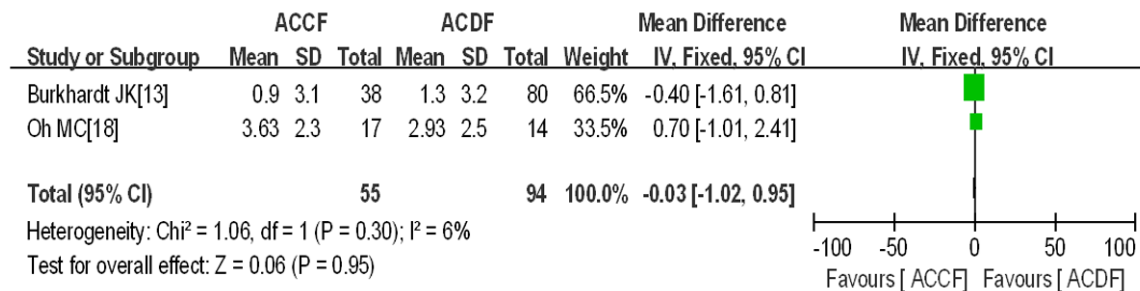
**Figure 2.** Forest plot of operation time between the ACCF group and ACDF group.



**Figure 3.** Forest plot of blood loss between the ACCF group and ACDF group.



**Figure 4.** Forest plot of postoperative JOA score between the ACCF group and ACDF group.



**Figure 5.** Forest plot of neck VAS score between the ACCF group and ACDF group.

model was used as the pooling method and the pooled results showed that there was no significant difference in the complications between the two groups [P=0.99, OR: 1.01 (0.50, 2.02); **Figure 11**], with low heterogeneity

(I<sup>2</sup>=6%). Of 52 patients, pseudarthrosis was reported in only 1 patient after ACCF [14]. Liu Jetal reported that four patients (18.2%) in group ACDF and five (20.8%) in group ACCF suffered from perioperative complications [15],

## Comparison of ACDF versus ACCF for treating CSM

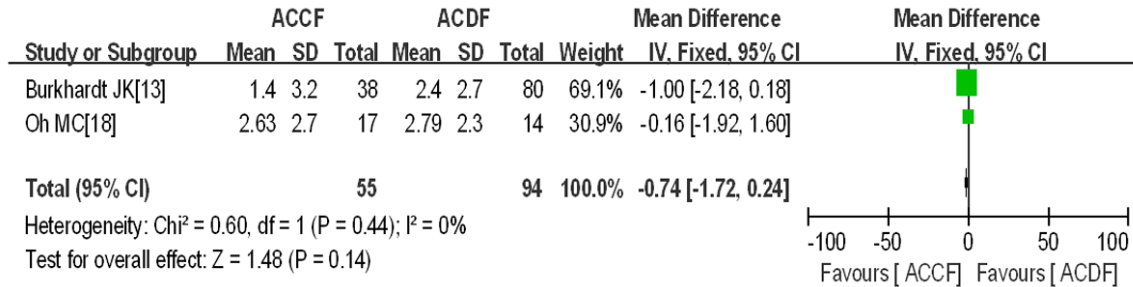


Figure 6. Forest plot of arm VAS score between the ACCF group and ACDF group.

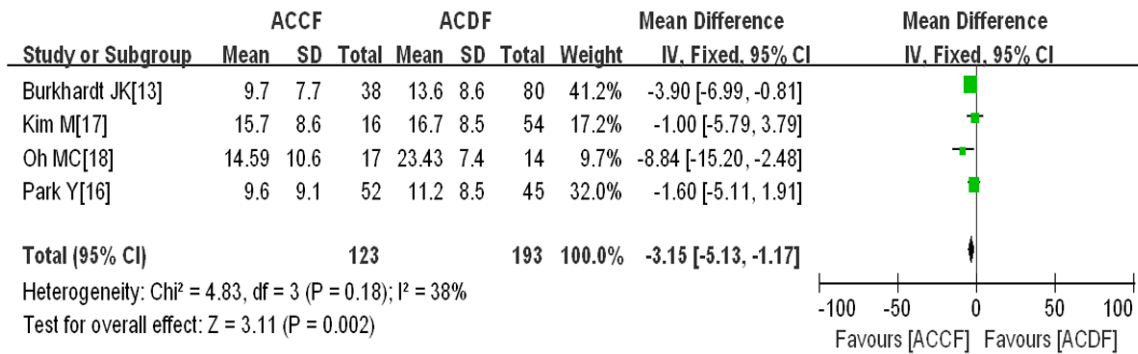


Figure 7. Forest plot of C2-C7 Cobb between the ACCF group and ACDF group at the final follow-up.

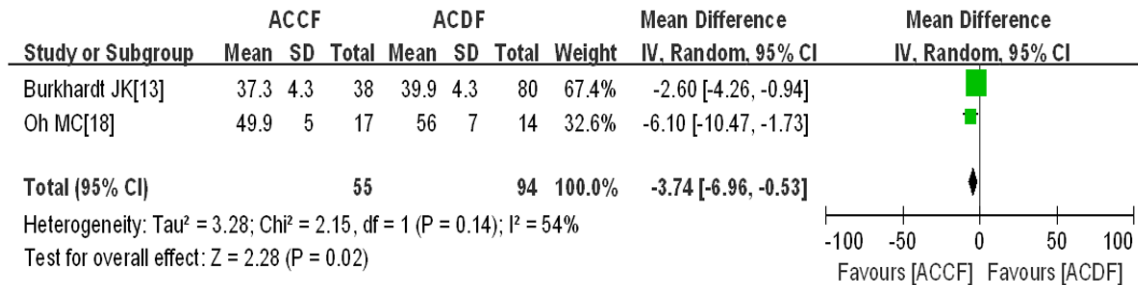


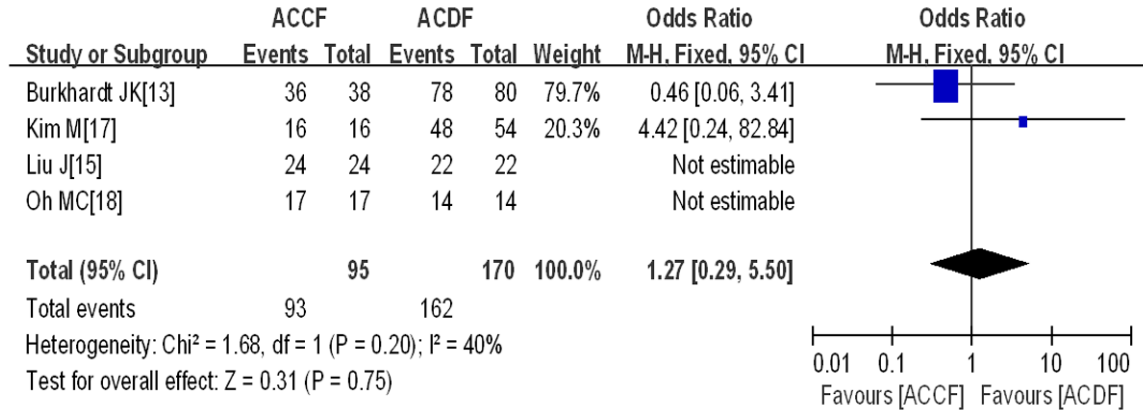
Figure 8. Forest plot of fused segment height between the ACCF group and ACDF group at the final follow-up.

two patients in group ACDF and three in group ACCF suffered from wound infection [15], C5 nerve root palsy occurred in one patient in group ACDF [15], one patient in group ACDF and two in group ACCF suffered dysphagia [15]. Kim Metal reported that Graft-related complications were developed in 2 patients in ACDF-AP, 5 patients in ACDF-CA, 3 patients in ACDF-CP, 3 patients in ACCF groups [17]. Oh MCetal reported that the ACCF group had 3 surgery-related complications including hoarseness, dura laceration, and postoperative upper extremity weakness [18].

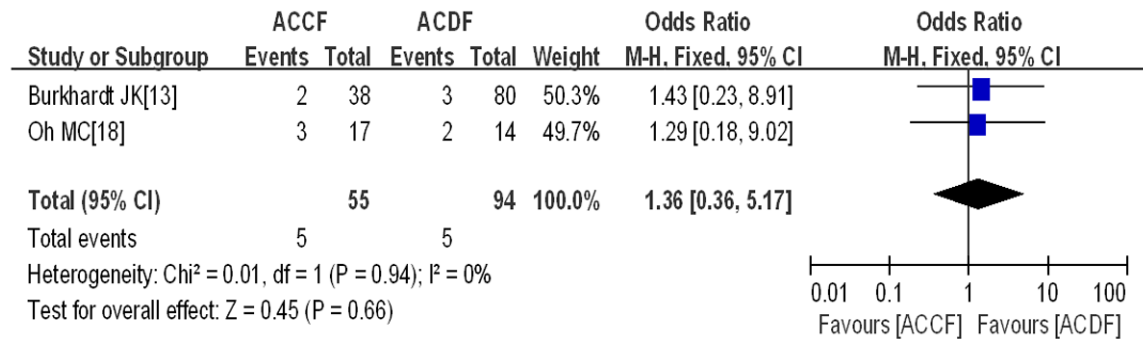
### Discussion

Cervical spondylotic myelopathy (CSM) is a common spinal disease caused by narrowing of the cervical spinal canal as a result of degenerative and congenital changes, and leads to significant neurological disability [19, 20]. Various approaches have been used to treat CSM, such as multilevel discectomy, corpectomy, laminectomy with/without fusion, laminoplasty, and laminectomy [21-25]. Anterior approach appears to be more suitable when the pathologies of anterior involve only 1 or 2

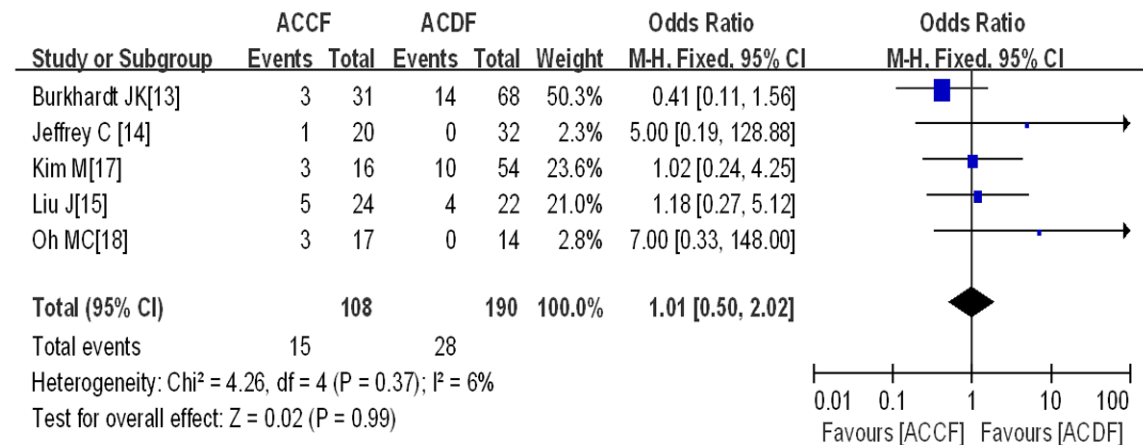
## Comparison of ACDF versus ACCF for treating CSM



**Figure 9.** Forest plot of fusion rate between the ACCF group and ACDF group at the final follow-up.



**Figure 10.** Forest plot of degeneration of the level adjacent to the fusion between the ACCF group and ACDF group at the final follow-up.



**Figure 11.** Forest plot of complications between the ACCF group and ACDF group at the final follow-up.

vertebral body levels, while if more than 2 levels usually proceed using an posterior approach clinically [26]. ACDF can remove the compressive pathology and reconstruct the alignment

of the cervical spine, yielding good clinical results. Surgeries involving anterior approaches include ACDF and ACCF. Although some relevant studies comparing the ACDF and ACCF

## Comparison of ACDF versus ACCF for treating CSM

have been reported, the evidence regarding whether ACDF is superior to ACCF remains ambiguous. We therefore conducted a meta-analysis to determine whether ACDF is associated with better clinical outcomes compared with ACCF.

Our meta-analysis showed that there was no significant difference in terms of complications, degeneration of the level adjacent to the fusion, fusion rate, arm and neck VAS score, postoperative JOA score between ACCF and ACDF. Compared with ACDF group, the blood loss and operation time were significant higher in the ACCF group, however, Cobb and fused segment height were significantly lower.

Previous study has stated that compared ACDF and ACCF to treat contiguous two-level CSM, ACDF has some advantages such as less blood loss, a shorter operation time, greater cervical lordosis in the total cervical and fused segments, a higher segmental height and less graft subsidence [9]. No significant differences in JOA, VAS, ROM or complications were found [9]. Our results are consistent with previous study [9]. Recent a meta-analysis reveals no significant difference in efficacy comparison between ACDF and ACCF, but the safety of ACDF was superior to ACCF with respect to the operation time, blood loss as well as hospital time [27]. However, another meta-analysis suggest that surgical treatments of multilevel CSM are similar in terms of most clinical outcomes using ACDF or ACCF [28]. Wen ZQ et al found that blood loss and complications during surgery in ACDF were significantly less than in ACCF; while other clinical outcomes were not significantly different [28].

We discovered that the safety of ACDF was significantly superior as compared to ACCF with regard to the operation time as well as blood loss. It has also been evidenced that 2-level ACDF was found to be superior to 1-level ACCF in terms of operation times, bleeding amounts, and radiologic results [18]. Furthermore, Liu J et al reported that two-level ACDF was found with less operation duration and blood loss, better cervical lordosis than those of single-level ACCF according to a long-term follow-up. ACDF requires less exposure of the spinal cord than does corpectomy [29]; therefore, less damage to the spinal column occurs. Accordingly, ACDF might result in less blood loss than

ACCF. In terms of ACCF, a 15-19 mm anterior midline trough should be performed in the vertebral body down to the posterior longitudinal ligament or dura, with removal of the cephalad and caudad discs [29], which would require more time to be removed; similarly it will cost more time to obtain a graft material to fit the trough. Consequently, ACDF had a significantly shorter operation time.

Our study shown that there was no statistically difference in JOA scores as well as VAS scores for neck and arm pain significantly improved between ACDF and ACCF. These results suggest that both procedures effectively treat contiguous two-level CSM and improve the patients' neurological function. Our results was in line with a previous study confirming that surgical managements of 2 segmental CSM by ACDF or ACCF showed no significant differences in terms of achieved clinical symptom improvements [18]. Recent study reported by Liu J et al also found that no significant different was noted between group ACDF and group ACCF in both the preoperative mJOA scores and postoperative mJOA scores [15]. These results were similar to previous studies [13, 30].

Meta-analysis revealed that as compared to ACDF group, Cobb were significant lower in the ACCF group. Consistent with our findings, previous studies demonstrated that ACCF was inferior to ACDF in terms of C2-7 angle improvement and segmental angle improvement [13, 16-18]. This may be associated with the following reason: Single-level ACCF takes out the vertebral body and two discs, while two-level ACDF just removes the two discs [29]; thus, ACDF allows the construction of an almost normal spinal column after surgery. As a result, the loss of Cobb is less common in ACDF. In other words, ACDF preserves the sagittal alignment somewhat better than does ACCF.

Compared with ACDF group, fused segment height were significantly lower in the ACCF group. With ACDFs, screws are placed in the intervening segment and two caudal end plates share the load of the construct [16]. In contrast, with a single-level corpectomy, screw purchase is only at the cranial and caudal vertebral segments and the caudal end plate bears the full load of the construct [16]. This may help to explain why single-level ACCF causes a significant reduction compared to ACDF.



## Comparison of ACDF versus ACCF for treating CSM

Concerning the fusion rate, the data showed that there is no significant difference between the two groups. Previous study reported higher fusion rates after ACCF than multi-level ACDF [31]. However, other studies demonstrated the opposite results [32, 33]. The fusion rate of two groups is quite high, it may be considered all patients used anterior plate fixation; which can provide a stable biomechanics environment for bone healing [34, 35].

In terms of complications, we found that there was no significant difference between the two groups. Liu J et al found that 18.2% of patients in group ACDF and 20.8% in group ACCF suffered perioperative complication [15]. However, the incidence of complications was not significantly different between the two groups [15]. This is consistent with our findings.

A previous report found that ACDF may alter the natural history of cervical spondylosis and hasten the development of degenerative changes at levels immediately above and below fused regions [36]. However, another study reported by Oh MC et al, showed that among the 31 patients, 2 in the ACDF group and 3 in the ACCF group showed adjacent degeneration, without a significant intergroup difference [18]. We also found that there was no significant difference in degeneration of the level adjacent to the fusion.

We believe that our result of meta-analysis is affected by several reasons. Firstly, in this meta-analysis, most the studies selected were not RCT, while it did not influence the credibility of the results. Secondly, there was variability among the studies in the choice of indicators to evaluate the postoperative clinical effect. This clearly reflects the lack of a gold standard outcome measure. Finally, clinical heterogeneity might be caused by the various indications for surgery and the surgical technologies used at the different treatment centers. Due to these limitations, the combined results of this meta-analysis should be cautiously accepted, and high-quality RCTs with long term follow-up and large sample size are needed.

Based on this meta-analysis, we conclude that although ACDF was significantly superior as compared to ACCF with regard to the operation time as well as blood loss, in terms of other clinical outcomes, such as complications,

degeneration of the level adjacent to the fusion, fusion rate, arm and neck VAS score, postoperative JOA score, there is no statistically significant difference between ACDF and ACCF for contiguous two-level CSM.

### Conclusions

In conclusion, our meta-analysis reveals that surgical treatments of contiguous two-level CSM are similar in terms of most clinical outcomes using ACDF or ACCF. However, owing to the limitations of the current study, high-quality clinical studies with larger sample sizes are still needed to confirm our results.

### Disclosure of conflict of interest

None.

**Address correspondence to:** Yuxin Zhang, Department of Spinal Surgery, The First People's Hospital of Kashgar Prefecture, Xinjiang 844000, Xinjiang Uyghur Autonomous Region, China. E-mail: 1589-173900@qq.com

### References

- [1] Edwards CC 2nd, Riew KD, Anderson PA, Hilibrand AS and Vaccaro AF. Cervical myelopathy. current diagnostic and treatment strategies. *Spine J* 2003; 3: 68-81
- [2] Lau D, Chou D and Mummaneni PV. Two-level corpectomy versus three-level discectomy for cervical spondylotic myelopathy: a comparison of perioperative, radiographic, and clinical outcomes. *J Neurosurg Spine* 2015; 23: 280-9.
- [3] Guan L, Hai Y, Yang JC, Zhou LJ and Chen XL. Anterior cervical discectomy and fusion may be more effective than anterior cervical corpectomy and fusion for the treatment of cervical spondylotic myelopathy. *BMC Musculoskelet Disord* 2015; 16: 29.
- [4] Luo J, Cao K, Huang S, Li L, Yu T, Cao C, Zhong R, Gong M, Zhou Z and Zou X. Comparison of anterior approach versus posterior approach for the treatment of multilevel cervical spondylotic myelopathy. *Eur Spine J* 2015; 24: 1621-1630.
- [5] Quinn JC, Kiely PD, Lebl DR and Hughes AP. Anterior surgical treatment of cervical spondylotic myelopathy: review article. *HSS J* 2015; 11: 15-25.
- [6] Caruso R, Pesce A, Marrocco L and Wierzbicki V. Anterior approach to the cervical spine for treatment of spondylosis or disc herniation: Long-term results. Comparison between ACD, ACDF, TDR. *Clin Ter* 2014; 165: e263-e270.

## Comparison of ACDF versus ACCF for treating CSM

- [7] Park HG, Kang MS, Kim KH, Park JY, Kim KS and Kuh SU. A surgical method for determining proper screw length in ACDF. *Korean J Spine* 2014; 11: 117-120.
- [8] McGirt MJ, Mehrlich M, Parker SL, Asher AL and Adamson TE. 165 ACDF in the outpatient ambulatory surgery setting: analysis of 1000 consecutive cases and comparison to hospital inpatient ACDF. *Neurosurgery* 2015; 62 Suppl 1: 220.
- [9] Huang ZY, Wu AM, Li QL, Lei T, Wang KY, Xu HZ and Ni WF. Comparison of two anterior fusion methods in two-level cervical spondylosis myelopathy: a meta-analysis. *BMJ Open* 2014; 4: e4581.
- [10] Guan L, Hai Y, Yang JC, Zhou LJ and Chen XL. Anterior cervical discectomy and fusion may be more effective than anterior cervical corpectomy and fusion for the treatment of cervical spondylotic myelopathy. *BMC Musculoskeletal Disord* 2015; 16: 29.
- [11] Han YC, Liu ZQ, Wang SJ, Li LJ and Tan J. Is anterior cervical discectomy and fusion superior to corpectomy and fusion for treatment of multilevel cervical spondylotic myelopathy? A systemic review and meta-analysis. *PLoS One* 2014; 9: e87191.
- [12] Jadad AR, Moore RA, Carroll D, Jenkinson C, Reynolds DJ, Gavaghan DJ and McQuay HJ. Assessing the quality of reports of randomized clinical trials: is blinding necessary? *Control Clin Trials* 1996; 17: 1-12.
- [13] Burkhardt JK, Mannion AF, Marbacher S, Dolp PA, Fekete TF, Jeszenszky D and Porchet F. A comparative effectiveness study of patient-rated and radiographic outcome after 2 types of decompression with fusion for spondylotic myelopathy: anterior cervical discectomy versus corpectomy. *Neurosurg Focus* 2013; 35: E4.
- [14] Wang JC, McDonough PW, Endow KK, Delamarter RB. A comparison of fusion rates between single-level cervical corpectomy and two-level discectomy and fusion. *J Spinal Disorders* 2001; 3: 222-225.
- [15] Liu J, Chen X, Liu Z, Long X, Huang S and Shu Y. Anterior cervical discectomy and fusion versus corpectomy and fusion in treating two-level adjacent cervical spondylotic myelopathy: a minimum 5-year follow-up study. *Arch Orthop Trauma* 2015; 135: 149-153.
- [16] Park Y, Maeda T, Cho W and Riew KD. Comparison of anterior cervical fusion after two-level discectomy or single-level corpectomy: sagittal alignment, cervical lordosis, graft collapse, and adjacent-level ossification. *Spine J* 2010; 10: 193-199.
- [17] Kim MK, Kim SM, Jeon KM, Kim TS. Radiographic comparison of four anterior fusion methods in two level cervical disc diseases: autograft plate fixation versus cage plate fixation versus stand-alone cage fusion versus corpectomy and plate fixation. *J Korean Neurosurg Soc* 2012; 51: 135-40.
- [18] Oh MC, Zhang HY, Park JY and Kim KS. Two-level anterior cervical discectomy versus one-level corpectomy in cervical spondylotic myelopathy. *Spine (Phila Pa 1976)* 2009; 34: 692-696.
- [19] Shamji MF, Massicotte EM, Traynelis VC, Norvell DC, Hermsmeyer JT and Fehlings MG. Comparison of anterior surgical options for the treatment of multilevel cervical spondylotic myelopathy: a systematic review. *Spine (Phila Pa 1976)* 2013; 38: S195-S209.
- [20] Kim HJ, Tetreault LA, Massicotte EM, Arnold PM, Skelly AC, Brodt ED and Riew KD. Differential diagnosis for cervical spondylotic myelopathy: literature review. *Spine (Phila Pa 1976)* 2013; 38: S78-S88.
- [21] Kristof RA, Kiefer T, Thudium M, Ringel F, Stoffel M, Kovacs A and Mueller C. Comparison of ventral corpectomy and plate-screw-instrumented fusion with dorsal laminectomy and rod-screw-instrumented fusion for treatment of at least two vertebral-level spondylotic cervical myelopathy. *Eur Spine J* 2009; 18: 1951-1956.
- [22] Wada E, Suzuki S, Kanazawa A, Matsuoka T, Miyamoto S and Yonenobu K. Subtotal corpectomy versus laminoplasty for multilevel cervical spondylotic myelopathy: a long-term follow-up study over 10 years. *Spine (Phila Pa 1976)* 2001; 26: 1443-1447, 1448.
- [23] Seng C, Tow BP, Siddiqui MA, Srivastava A, Wang L, Yew AK, Yeo W, Khoo SH, Balakrishnan NM, Bin Abd Razak HR, Chen JL, Guo CM, Tan SB and Yue W. Surgically treated cervical myelopathy: a functional outcome comparison study between multilevel anterior cervical decompression fusion with instrumentation and posterior laminoplasty. *Spine J* 2013; 13: 723-731.
- [24] Liu T, Yang HL, Xu YZ, Qi RF and Guan HQ. ACDF with the PCB cage-plate system versus laminoplasty for multilevel cervical spondylotic myelopathy. *J Spinal Disord Tech* 2011; 24: 213-220.
- [25] Pagonis TA. Re: Fehlings MG, Barry S, Kopjar B, Yoon ST, Arnold P, Massicotte EM, Vaccaro A, Brodke DS, Shaffrey C, Smith JS, Woodard E, Banco RJ, Chapman J, Janssen M, Bono C, Sasso R, Dekutoski M and Gokaslan ZL. Anterior versus posterior surgical approaches to treat cervical spondylotic myelopathy: outcomes of the prospective multicenter AOSpine north America CSM study in 264 patients. *Spine* 2013; 38: 2247-2252. *Spine (Phila Pa 1976)* 2014; 39: 1264.

## Comparison of ACDF versus ACCF for treating CSM

- [26] Cabraja M, Abbushi A, Koeppen D, Kroppenstedt S and Woiciechowsky C. Comparison between anterior and posterior decompression with instrumentation for cervical spondylotic myelopathy: sagittal alignment and clinical outcome. *Neurosurg Focus* 2010; 28: E15.
- [27] Xiao SW, Jiang H, Yang LJ and Xiao ZM. Anterior cervical discectomy versus corpectomy for multilevel cervical spondylotic myelopathy: a meta-analysis. *Eur Spine J* 2015; 24: 31-9.
- [28] Wen ZQ, Du JY, Ling ZH, Xu HD and Lin XJ. Anterior cervical discectomy and fusion versus anterior cervical corpectomy and fusion in the treatment of multilevel cervical spondylotic myelopathy: systematic review and a meta-analysis. *Ther Clin Risk Manag* 2015; 11: 161-170.
- [29] Rao RD, Gourab K and David KS. Operative treatment of cervical spondylotic myelopathy. *J Bone Joint Surg Am* 2006; 88: 1619-1640.
- [30] Aghayev K, Doulgeris JJ, Gonzalez-Blohm SA, Eleraky M, Lee WR and Vrionis FD. Biomechanical comparison of a two-level anterior discectomy and a one-level corpectomy, combined with fusion and anterior plate reconstruction in the cervical spine. *Clin Biomech (Bristol, Avon)* 2014; 29: 21-25.
- [31] Nirala AP, Husain M and Vatsal DK. A retrospective study of multiple interbody grafting and long segment strut grafting following multilevel anterior cervical decompression. *Br J Neurosurg* 2004; 18: 227-232.
- [32] Uribe JS, Sangala JR, Duckworth EA and Vale FL. Comparison between anterior cervical discectomy fusion and cervical corpectomy fusion using titanium cages for reconstruction: analysis of outcome and long-term follow-up. *Eur Spine J* 2009; 18: 654-662.
- [33] Liu Y, Hou Y, Yang L, Chen H, Wang X, Wu X, Gao R, Wang C and Yuan W. Comparison of 3 reconstructive techniques in the surgical management of multilevel cervical spondylotic myelopathy. *Spine (Phila Pa 1976)* 2012; 37: E1450-E1458.
- [34] Singh K, Vaccaro AR, Kim J, Lorenz EP, Lim TH and An HS. Enhancement of stability following anterior cervical corpectomy: a biomechanical study. *Spine (Phila Pa 1976)* 2004; 29: 845-849.
- [35] Setzer M, Eleraky M, Johnson WM, Aghayev K, Tran ND and Vrionis FD. Biomechanical comparison of anterior cervical spine instrumentation techniques with and without supplemental posterior fusion after different corpectomy and discectomy combinations: Laboratory investigation. *J Neurosurg Spine* 2012; 16: 579-584.
- [36] Baba H, Furusawa N, Imura S, Kawahara N, Tsuchiya H and Tomita K. Late radiographic findings after anterior cervical fusion for spondylotic myeloradiculopathy. *Spine (Phila Pa 1976)* 1993; 18: 2167-2173.