



Comparison of Multilevel Cervical Disc Replacement and Multilevel Anterior Discectomy and Fusion: A Systematic Review of Biomechanical and Clinical Evidence

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Key words

- Anterior cervical discectomy and fusion
- Cervical disc replacement
- Clinical and biomechanical efficiency
- Multilevel cervical disc disease

Abbreviations and Acronyms

ACDF: Anterior cervical discectomy and fusion
ACDR: Artificial cervical disc replacement
ASD: Adjacent segment disease
CDD: Cervical disc disease
CI: Confidence interval
FEA: Finite element analysis
JOA: Japanese Orthopaedic Association
MD: Mean difference
MINORS: Methodological Index for Non-Randomized Studies
NDI: Neck Disability Index
OR: Odds ratio
RCT: Randomized controlled trial
ROM: Range of motion
VAS: Visual analog scale

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INTRODUCTION

Combined anterior cervical discectomy and fusion (ACDF) has been a widely used surgical intervention for treating symptomatic cervical disc disease (CDD).^{1,2} However, various reports suggest that ACDF may ultimately result in adverse

■ **OBJECTIVE:** The aim of this study was to comprehensively compare the clinical and biomechanical efficiency of anterior cervical discectomy and fusion (ACDF) with anterior cervical disc replacement (ACDR) for treatment of multi-level cervical disc disease using a meta-analysis and systematical review.

■ **METHODS:** A literature search was performed using PubMed, MEDLINE, EMBASE, and the Cochrane Library for articles published between January 1960 and December 2017. Both clinical and biomechanical parameters were analyzed. Statistical tests were conducted by Revman 5.3. Nineteen studies including 10 clinical studies and 9 biomechanical studies were filtered out.

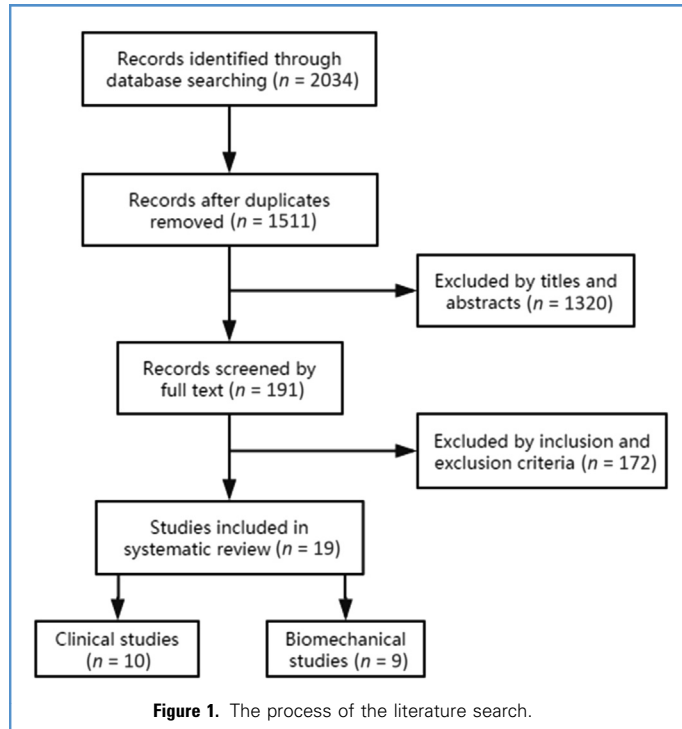
■ **RESULTS:** The pooled results for clinical efficiency showed that no significant difference was observed in blood loss ($P = 0.09$; mean difference [MD], 7.38; confidence interval [CI], -1.16 to 15.91), hospital stay ($P = 0.33$; MD, -0.25; CI, -0.76 to 0.26), Japanese Orthopaedic Association scores ($P = 0.63$; MD, -0.11; CI, -0.57 to 0.34), visual analog scale ($P = 0.08$; MD, -0.50; CI, -1.06 to 0.05), and Neck Disability Index ($P = 0.33$; MD, -0.55; CI, -1.65 to 0.56) between the 2 groups. Compared with ACDF, ACDR did show increased surgical time ($P = 0.03$; MD, 31.42; CI, 2.71–60.14). On the other hand, ACDR showed increased index range of motion (ROM) ($P < 0.00001$; MD, 13.83; CI, 9.28–18.39), lower rates of adjacent segment disease (ASD) ($P = 0.001$; odds ratio [OR], 0.27; CI, 0.13–0.59), complications ($P = 0.006$; OR, 0.62; CI, 0.45–0.87), and rate of subsequent surgery ($P < 0.00001$; OR, 0.25; CI, 0.14–0.44). As for biomechanical performance, ACDR maintained index ROM and avoided compensation in adjacent ROM and tissue pressure.

■ **CONCLUSIONS:** Multilevel ACDR may be an effective and safe alternative to ACDF in terms of clinical and biomechanical performance. However, further multicenter and prospective studies should be conducted to obtain a stronger and more reliable conclusion.

changes at the adjacent level in biomechanical performances, including increased motion and intradiscal pressure.³ In recent years, anterior cervical disc replacement (ACDR), as an alternative to fusion surgery, has been developed to mitigate some of the challenges caused by arthrodesis through maintaining index level motion and decreasing motion compensation of adjacent segments.^{4,5} Previous studies have indicated that single-level arthroplasty is a safe and efficient alternative to traditional fusion because it provided statistically significant clinical and functional outcomes.^{6,7} Furthermore, 5-year clinical follow-up

results indicated that no obvious changes were observed in the range of motion (ROM), functional spinal unit angle, sagittal translation, and so on, with single-level ACDR.⁸ It was also reported that single-level arthroplasty decreased readmission and reoperation rates compared with cervical fusion.⁹

Multilevel CDD is a common symptomatic disease in clinic.¹⁰ Multilevel arthroplasty, to some extent, is an attractive procedure because of the success of single-level ACDR. Previous biomechanical studies reported that 2-level arthroplasty preserved motion at implanted levels^{11,12} and showed more



similar cervical motion patterns than did arthrodesis.¹² However, multilevel ACDF involved stricter indications¹³ and a higher possibility of device-related complications.¹⁰ There are limited clinical and biomechanical studies exploring the efficiency of multilevel ACDF compared

with ACDF. Therefore, the clinical role of multilevel ACDF should be further evaluated.

This systematic review focused on the comparison between multilevel ACDF and ACDF in clinical outcomes and biomechanical performances. Specifically, we

comprehensively examined the efficiency of multilevel ACDF for treatment of multilevel CDD. We hypothesized that ACDF is a safe and effective intervention for treatment of multilevel CDD.

METHODS

Search Strategy

Electronic databases including PubMed, MEDLINE, EMBASE, and the Cochrane Library were selected for identifying relevant articles from January 1960 to December 2017. All studies that compared ACDF and ACDF for treatment of multilevel CDD published in English were identified using the following search terms: 1) cervical spine OR cervical degenerative disc disease OR cervical spondylotic myelopathy OR intervertebral disc degeneration; 2) replacement OR arthroplasty OR CDR; 3) anterior cervical discectomy and fusion OR cervical decompression OR ACDF OR arthrodesis; 1) and 2) and 3). Two reviewers independently screened subjects and abstracts of the primary identified studies. Full texts of all potentially eligible studies were read carefully.

Inclusion and Exclusion Criteria

Studies were included when they met the following criteria: 1) study design: randomized or nonrandomized controlled clinical studies, finite element analysis

Table 1. Basic Information for Each Study

Study	Design	Location	Sample Size		Mean Age (years)		Prosthesis	Segment Number	Follow-Up (months)
			ACDR	ACDF	ACDR	ACDF			
Kim et al., 2009 ¹⁶	Non-RCT	South Korea	12	28	46.91	52.7	Bryan	2	18–21
Fay et al., 2014 ¹⁷	Non-RCT	Taiwan	37	40	52.1	63.0	Bryan	2	39.6
Hou et al., 2014 ¹⁸	Non-RCT	China	32	88	46.3	51.2	DISCOVER	2	23.5
Hey et al., 2013 ¹⁹	Non-RCT	Singapore	7	7	46	48	Prodisc-C	2 and 3	24–25
Grasso, 2015 ²⁰	Non-RCT	Italy	20	20	40.5	47.3	Prodisc-C or Mobi-C	2	>24
Shang et al., 2017 ²¹	Non-RCT	China	18	31	48.7	49.3	Bryan	2	48
Cheng et al., 2009 ²²	RCT	China	31	34	45	47	Bryan	2	24
Sun et al., 2016 ²³	RCT	China	14	16	46.79	48.13	DISCOVER	2	32.4
Lanman et al., 2017 ²⁴	RCT	USA	209	188	47.1	47.3	Prestige LP	2	84
Radcliff et al., 2017 ²⁵	RCT	USA	225	105	45.3	46.2	Mobi-C	2	84

RCT, randomized controlled trial.

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