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Cervical disc arthroplasty for the treatment of adjacent segment disease: A systematic review of clinical evidence

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ABSTRACT

The safety and efficacy of cervical disc arthroplasty (CDA) performed adjacent to previous fusion for the treatment of adjacent segment disease (ASD) remains unknown. This systematic review summarizes clinical evidence on the outcomes of CDA performed adjacent to previous cervical fusion. A systematic search of PubMed, Cochrane Central Register of Controlled Trials (CENTRAL), Medline and Embase for literature published through March 2017 was conducted. All the studies on CDA for the treatment of ASD after cervical fusion surgery were included. Two independent reviewers searched and assessed the literature according to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses guidelines (PRISMA). A total of 5 studies were identified. The overall quality of evidence was low. All included studies demonstrated that clinical outcomes reflected by several assessment scales improved after arthroplasty. Cervical lordosis range of motion (ROM) after arthroplasty remained and was even enhanced postoperatively. The rate of complications and subsequent surgeries was low. There is a dearth of information regarding the outcomes of CDA for the treatment of ASD in the literature. In general, CDA may be a safe and effective surgical procedure to treat ASD, but this conclusion needs to be confirmed by future long-term, prospective clinical trials.

1. Introduction

Anterior cervical discectomy and fusion (ACDF) has been widely performed as the gold standard surgical technique for the treatment of cervical spondylosis refractory to conservative therapy since the 1950s [1–3]. Although this procedure has achieved high success rates in short- to long-term follow-up [1,4–9], one potential long-term consequence of ACDF is adjacent segment disease (ASD), which is defined as development of new radiculopathy or myelopathy referable to a motion segment adjacent to the site of a previous anterior arthrodesis of the cervical spine [10,11]. In recent decades, several studies concluded that the prevalence of symptomatic ASD was between 9%-38.1% with an annual incidence of secondary surgery for ASD ranging from 0.8% to 4% [1,4,6–9,12–15].

Given the frequency of ACDF performed, ASD may affect an increasing number of patients and secondary surgery is required when conservative management fails. With regard to secondary surgery, spine surgeons always prefer to perform ACDF adjacent to a previously fused segment [16–19]. However, fusion rate was significantly lower when ACDF was performed adjacent to a previous fusion site [16,20]. Furthermore, a second cervical fusion for ASD was significantly more likely to develop recurrent ASD and obviously reduced the patient's quality of life [21]. Additionally, ACDF adjacent to a previous fusion leads to more loss of cervical mobility which extremely increases the motion and stress on the remaining mobile segments.

Cervical disc arthroplasty (CDA), an alternative technique to ACDF, is designed to preserve motion of the operated level and decrease the incidence of ASD. Several short- and mid-term follow-up studies have been published from Investigational Device Exemption (IDE) trials associated with the US Food and Drug Administration (FDA) approval process for CDA to treat patients with cervical radiculopathy and/or myelopathy [22–29]. To date, most clinical trials, however, excluded patients who underwent previous cervical surgery. There is a paucity of evidence supporting the beneficial effect of CDA for the treatment of ASD in patients who underwent previous surgery.

Whether CDA is suitable for patients who undergone previous surgery remains an unsolved issue. Therefore, we performed this systematic literature review of the currently available clinical data on CDA adjacent to a cervical fused segment and aimed to provide a foundation for evidence on the safety and efficacy on CDA for the treatment of ASD

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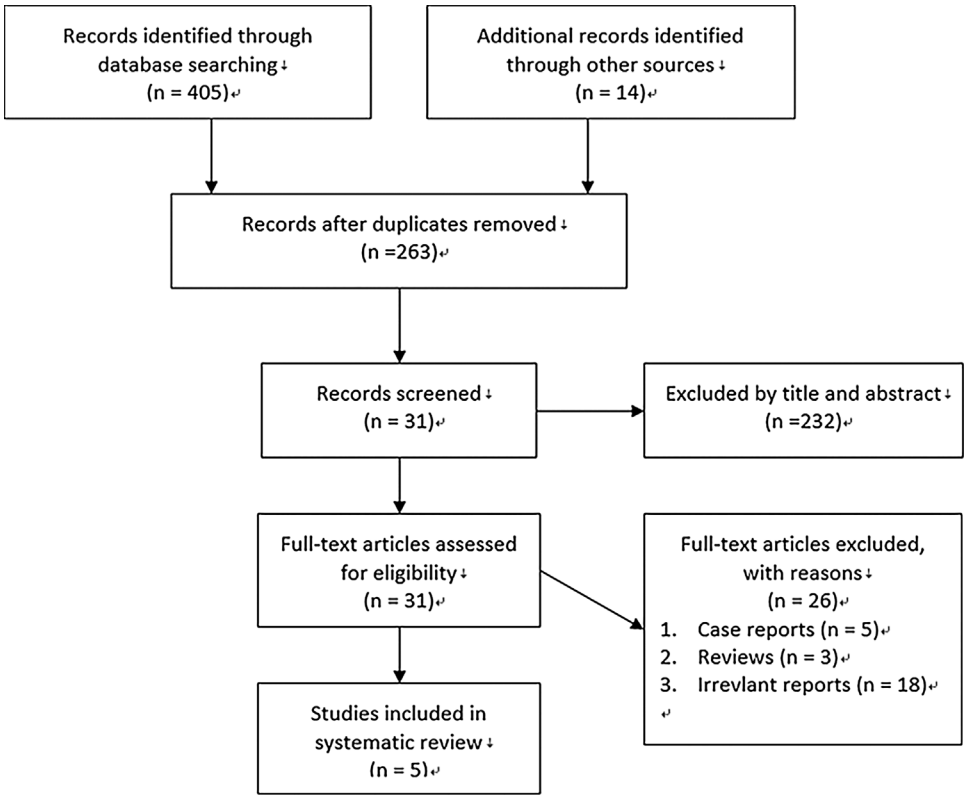

Fig. 1. Flow chart of the study selection process.

after fusion. To the best of our knowledge, this report is the first review study on this subject.

2. Methods

2.1. Study selection

This review was conducted according to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines [30]. As all the analyses were performed based on previously published trials, ethical approval and informed consent for this study were not necessary. We conducted a systematic search in PubMed, Cochrane Central Register of Controlled Trials (CENTRAL), Medline and Embase for literature published from January 1960 to March 2017. There was no language limitation. The search strategy included use of medical subject headings (MeSH) terms and keywords. MeSH terms included: arthroplasty, arthrodesis, cervical vertebrae and reoperation, and multiple keywords included cervical disc arthroplasty; cervical disc replacement; adjacent segment degeneration; adjacent segment disease; adjacent segment pathology; fusion; reoperation; subsequent surgery; additional surgery and second surgery. All studies involving CDA for the treatment of ASD after fusion were specifically identified. Additionally; the reference lists of all selected full-text articles were manually reviewed to identify more eligible articles.

Two reviewers (Dr. Wang and Dr. Deng) independently performed the first screening as a function of title and abstract. The full-text articles were read for further assessment if eligibility was met by screening the abstracts. If there was any disagreement between reviewers, they discussed and reached a consensus. If disagreement could not be resolved, the third author (Dr. Liu) was consulted. The inclusion criteria were (1) adults who had previous fusion surgery diagnosed with degenerative disorders adjacent to fusion mass and (2) cervical disc arthroplasty for the treatment of ASD. The exclusion criteria were (1) No ASD at treatment, (2) revision surgery at the original operated level, (3) studies concentrated on tumor, infection, neuromuscular scoliosis or inflammatory diseases, (4) case reports, (5) studies with patients less than 5, (6) reviews, and (7) biomechanical studies.

2.2. Data extraction

From the included articles, two independent reviewers (Dr. Wang and Dr. Deng) extracted the relevant data, including year of publication, country, study design, study purpose, population demographics, inclusion and exclusion criteria, follow-up duration, surgical interventions, outcomes and complications.

2.3. Quality assessment

The methodological quality of the studies was independently evaluated by two reviewers (Dr. Wang and Dr. Deng). Disagreements were resolved through discussion, and if not, the third author (Dr. Liu) was consulted if disagreement could not be resolved. We used the Grades of Recommendation Assessment, Development and Evaluation (GRADE) system [31,32] to evaluate the overall quality of the included studies in this review. The internal validity of the included studies was assessed using different evaluation system due to the different study designs. For randomized controlled studies, quality assessment was conducted following the guidelines in the Cochrane Handbook for Systematic Review of Interventions [33]. The following domains were evaluated: random sequence generation, allocation concealment, blinding of the patients, blinding of care providers, blinding of outcome assessors, drop-out rate, intention-to-treat analysis, selective outcome reporting, similarity at baseline, co-interventions, acceptable complications and similar timing of outcome assessment. The risk of bias was classified as low risk, unclear risk or high risk. For non-randomized controlled trials, quality was assessed using the methodological index for non-randomized studies (MINORS) [34]. The methodological quality assessment contained 12 items. The first subscale of eight items was related to non-comparative studies whereas all 12 items were relevant to comparative studies. The ideal global score would be 16 for non-comparative studies and 24 for comparative studies.