Research Article

Cervical Arthroplasty versus Anterior Cervical Discectomy and Fusion: Myth and Facts

Hesham Abo Rahma
Department of Neurosurgery, Menofyia University

Abstract

Background: Adjacent segment disease has been noticed following anterior cervical discectomy and fusion. Cervical arthroplasty has been developed over the last few years as a "treatment" option for cervical disc disease that would prevent the occurrence of adjacent segment disease. **Material and Methods:** This retrospective study comparing the clinical and radiological outcome in cases operated by cervical artificial disc and those operated by anterior cervical discectomy and fusion with A systematic search was conducted in PubMed for human randomized control trials in English language literature published through January ٢٠١٣. Answers for the following key questions were sought: (١) The incidence of adjacent segment disease following anterior cervical fusion (ACDF) versus cervical anthroplasty (C-TDR). (٢) Is there evidence that cervical arthroplsty (C-TDR) is associated with lower incidence of adjacent segment pathology (ASP). (٣) Is there evidence that cervical arthroplasty (C-TDR) has a superior long term effectiveness compared to cervical fusion. (٤) Is there long term durability of maintenance of motion at the operated site following (C-TDR). (٥) Is there a long term mechanical durability of the artificial cervical disc? **Results:** A total of ١٨ patients were operated by CTDR compared to ٣٤ patients operated by ACDF The initial literature yielded ١٤٤ citations, of which ٤١ unique, potentially relevant citations that were evaluated against the inclusion/exclusion criteria. * Radiological Adjacent Segment pathology (RASP) was variably reported following (Total disc replacement) compared to anterior cervical fusion (ACDF) and ranged between ١.٠٪ to ٤.٨٪ with no statistically significant difference between the two groups. * No long term follow up study comparing the clinical as well as radiological outcome following both techniques was found. *There is no significant difference in development of RASP and CASP after C-TDR versus ACDF at short to mid-term follow up. **Conclusion:** (١) C-TDR is superior to ACDF at ٥ years follow up in NDI, neurological success, and index level reoperation. (٢) No statistical difference in the incidence of CASP at ٥ years. (٣) No strong evidence to support the routine use of C-TDR over ACDF. (٤) C-TDS as a new technology is associated with an expanding list of novel complication of physiological motion at the operated site as preservation of a matter of thought (٥) Long term mechanical durability of the device is still a challenging issue.

Key words: cervical spondylotic mylopathy, cervical radiculopathy, cervical adjacent segment disease, cervical arthroplasty.

Introduction

Symptomatic cervical disc disease may present as radiculopathy, myelopathy, axial neck pain, or some combination of all. Anterior cervical discectomy and fusion (ACDF) has provided excellent direct spinal cord and root compression. Despite its long clinical history and widespread utilization, there is some concerns about adjacent level degeneration. Cervical arthroplasty is a relatively novel motion-preserving procedure with promising results based on the assumption that motion-preservation devices e.g. arthroplasty would prevent or lower the incidence of adjacent segment degeneration.

Radiological adjacent segment pathology (RASP) refers to the progressive changes that may occur at the adjacent segment after spinal surgery, if RASP becomes symptom-matic, then it is called adjacent segment disease.

Adjacent segment pathology may be explained by the theory stating that

elimination of the motion at the index level of the fusion leads to increased compensatory motion at the adjacent segments, such alterations in adjacent segment kinematics and biomechanics may lead to more rapid degeneration that would occur without fusion.

Biomechanical studies confirmed the fact that after anterior cervical fusion, there is an increase in the adjacent segment range of motion (ROM), altered center of rotation (CoR), increased bending movement, and increased intradiscal pressure. Furthermore, in vitro studies have shown that cervical arthroplasty may help to avoid these abnormal effects. However, whether there are kinematic differences at the adjacent segment after fusion versus arthroplasty surgery has not yet been confirmed on patients.

The aim of this review is to perform an evidence-based analysis of the literature regarding the facts and myths of using artificial disc and to highlight its role in decreasing the incidence of adjacent segment pathology (ASP). In addition, to determine whether one type of artificial disc implants is associated with a lower risk of (ASP).

Material and Methods

We conducted a systemic search in PubMed for literature published through January ٢٠١٣. We included studies evaluating adult patients who had surgery for cervical disc through anterior approach. Included were only studies that focus on the incidence of (ASP) following (TDR) or (ACDF) for single level central disc disease and excluding other indications like infection, tumor, trauma, deformity or ankylosing spondylitis. Also, focusing on studies that contain kinematic measures such as adjacent level ROM, disc height, lordosis, angle change at adjacent levels and antroposterior translation together with frequency of ASP. Other exclusions include multilevel (TDR), cadaver studies and case reports and non-English literature.

Table I: Inclusion and exclusion criteria for literature review in the study

	Inclusion	Exclusion
Patient	- Adult - Single level cervix disc disease presented with (a) Radiculopathy (b) Mylopathy (c) Symptomatic central spine strains	- <١٨ y - Psorias cervix disc surgery - Multiple level - Infection, tumor, trauma, deformity
Intervention	- Total cervical disc replacement (TDR)/ Arthroplasty	- Laminectomy - Lamino foramenotomy - Laminoplasty - Corpetomy - Simple discectomy
Comparison	- Anterior cervical fusion (ACDF)	
Outcome	- Range of motion (ROM) - Adjacent segment disease (ASD) - Lordosis - Kinematic measures	

Data extraction

From the included articles, the following data were extracted:
Patients' demographics, type of implant, follow up duration, incidence of (ASP), clinical and radiological outcome.

Discussion

Currently, much controversy centers on the development of subsequent radiological (RASP) and clinical adjacent segment pathology (CASP) that sometimes require additional treatment. RASP and CASP are

terms that represent an attempt to streamline and facilitate meaningful terms for which future research may center regarding the topics related to adjacent segment pathological conditions. Prior nomenclature (adjacent segment degeneration or disease) was poorly defined and created varied and ambiguous literature regarding the topics. Debate remains regarding whether this subsequent disc degeneration is the result of the patient's natural history or related to the biomechanical effects of fusion. Concern regarding the effect of cervical fusion on adjacent segments has led to increased interest in motion-sparing procedures such as arthroplasty, foraminotomy, and laminoplasty.

Botelho et al., [١] published a systematic review evaluating the rates of adjacent segment degenerative disease in subjects who underwent cervical total disc replacement (TDR) compared with fusion procedures. They limited their search to randomized controlled trials (RCTs), studies for which the primary outcome was presence of adjacent segment pathology (ASP), and studies with at least ٢ years of follow-up following the surgical procedure. No articles compared the rates of RASP, while one study provided rates for adjacent-level surgery and was further evaluated.[٢] The authors found the relative risk of development of ASP in TDR compared with fusion to be ٠.٣٠ (٩٥٪ CI: ٠.٠٨, ١.٠٨) and concluded that RASP has not been adequately studied in a review of available RCTs on this topic.

In a more recent systematic review, Riew et al., [٣] assessed the rates and time to development of RASP and/or CASP after TDR compared with fusion procedures for cervical degenerative disc disease. The search was limited to studies of primary United States Food and Drug Administration (FDA) trials for devices with longer follow-up (at least ٢٤ mo). The authors reported that the risk differences between TDR and fusion for CASP were ١.٥٪-٢.٣٪ and were not significantly different across studies, while rates of RASP were variable between studies, likely due to different RASP definitions. Time to development of ASP did not significantly differ between treatments. No statistically significant differences in adjacent segment range of motion (ROM) were noted between treatment groups.

Ryu et al.,,[١٩] evaluated consecutive patients with single-level degenerative cervical spine diseases who underwent TDR using a Bryan disc (N=١٩) or a ProDisc-C (N=١٧), with all procedures performed by a single surgeon. The mean follow-up time was ٢٧.٣±٤.٩ (range ٢٤-٤٠) months, and the rate of follow-up was ٧٨.٣٪ (٣٦/٤٦). Radiographical assessments were performed twice by ٢ independent observers on high-resolution CTs, and RASP was defined as degenerative changes, spur formation and/or progression of facet arthrosis at adjacent levels. RASP was reported by level, though not for subjects. For the Brayn disc group, the risk of RASP was ٧.٩٪ (٣/٣٨ levels) and was ٨.٨٪ (٣/٣٤ levels) for subjects who received the ProDisc-C (R=٠.٩٠, ٩٥٪ CI: ٠.١٩, ٤.١٤).

Nunley et al., [١٧] stated that it is not clear from these studies that radiographic pathological changes at segments adjacent to fusion or motion-sparing devices are related to patient symptoms or function. Small sample sizes in some studies may have contributed to lack of statistical significance for differences between treatment groups. They were unable to determine whether the current evidence reflects the true effect. Independently funded, blinded long-term follow-up studies would be able to delineate the true effect of TDR versus fusion regarding incidence of RASP and CASP and treatment of CASP.

Nabhan et al., [١٢] performed a RCT in which they assessed segmental motion following implantation of the ProDisc-C disc compared with fusion surgery in subjects who underwent single-level treatment for symptomatic cervical disc disease. The follow-up rate at ٣٦ months was ٨٧.٧٪ (٤١/٤٩). Reoperation at the adjacent level was reported to be ٠٪ (٠/٢٠) for subjects who received the ProDisc-C and ٤.٨٪ (١/٢١) for fusion subjects (RR= not able to calculate). The index report of the same population at the ١٢-month

follow-up has been published; however, the definition of ASP was not clearly defined in this study with less follow-up. [٢٢]

In the study by Coric et al.,[١٠], treatment for CASP was performed in ٧.٦٪ (٩/١١٩) for Kineflex/C subjects and ٦.١٪ (٧/١١٥) in those who underwent fusion (R=١.٢٤, ٩٥٪ CI: ٠.٤٨, ٣.٢٣).

The cohort study by Park et al.,[١٨] reported no reoperation due to ASP for either group (RR= ٠.٦٠, ٩٥٪ CI: ٠.٢٢, ١.٦١).

Nunley et al.,[١٧] evaluated a cohort of subjects from ٢ collaborating institutions who had participated in ١ of ٣ different FDA IDE RCTs. Participating subjects had ١- or ٢-level cervical degenerative disease and received either TDA with implantation of the Kineflex-C, Mobi-C or Advent cervical disc or fusion surgery. This prospective cohort study reported on subjects who were followed for a median of ٣٨ (range ٣٢-٥٤) months and reported a follow-up rate of ٩٣.٤٪ (١٧٠/١٨٢). ASP was assessed through a multistep process in which RASP was first assessed radiographically and was rated as no, mild, moderate, or severe disease, followed by clinical assessment with electrophysiologic (electromyography and nerve conduction velocity) studies to rule out peripheral nerve pathologies. Once the existence of ASP was established medical and/or surgical management of ASP was carefully recorded. Only those subjects who demonstrated clinical-radiological stigmata of ASP, the rate for CASP and treatment for CASP were higher for anthroplasty, and were reported to be ١٧.٦٪ (٢٠/١١٣) for subjects who underwent TDR and ١٤.٠٪ (٨/٥٧) for the fusion group (RR= ١.٢٦. ٩٥٪ CI: ٠.٥٩, ٢.٦٩). It is our note that this is the only study out of these ٨ studies cited which was not industry funded.

Conclusion

C-TDR is superior to ACDF at ٥ years follow up in NDI, neurological success, and index level reoperation. No statistical difference in the incidence of CASP at ٥ years. No strong evidence to support the routine use of C-TDR over ACDF. C-TDS as a new technology is associated with an expanding list of novel complication of physiological motion at the operated site as preservation of a matter of thought. Long term mechanical durability of the device is still a challenging issue.

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