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Clinical Study

The impact of coronal alignment of device on radiographic degeneration in the case of total disc replacement

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Abstract

BACKGROUND CONTEXT: Numerous studies have been conducted on the importance of radiographic parameters after a total disc replacement (TDR). Most of them have focused on sagittal alignment. There has been no research on what influence the coronal alignment or tilting of device has on radiographic parameters.

PURPOSE: The aim was to investigate the influences of coronal tilting of device on radiographic parameters and degeneration.

STUDY DESIGN/SETTING: This was a prospective comparative study.

PATIENT SAMPLE: A total of 180 patients with single-level cervical disc disease who underwent TDR were included.

OUTCOME MEASURES: Overall and functional spinal unit (FSU) sagittal range of motion (ROM), coronal alignment (or tilting) of device, and postoperative radiographic degeneration (RD) were analyzed.

METHODS: Static anteroposterior, lateral X-rays, and dynamic lateral radiographs were assessed preoperatively, postoperatively, at 1.5, 3, 6, 9, 12, 18, 24 months, and every 6 months thereafter until final follow-up. A correlation with various parameters that could result in RD was investigated, For this, the patients were divided into two groups (Group I, RD; Group II, no RD) and subdivided into Group I-A ($<5^\circ$; low coronal tilt) and Group I-B ($\geq 5^\circ$; high coronal tilt) to analyze whether coronal tilting of device was correlated with RD.

RESULTS: No statistical differences were found in preoperative overall and FSU ROM, postoperative overall and FSU ROM between Groups I and II. However, there was significant difference in coronal tilting of device between Groups I ($4.50\pm2.83^\circ$) and II ($2.04\pm1.15^\circ$; p=.001). There were no significant differences in preoperative overall and FSU ROM, postoperative overall and FSU ROM between Group I-A and I-B. But, RD incidence rate at surgical segment in Group I-A was 23.1%, whereas that in Group I-B was 75.0% (p=.001). The influence level of a difference in the incidence rate was found to be 10.0 of the odds ratio. Radiographic degeneration incidence rate at adjacent levels in Group I-A was 8.33%, whereas that in Group I-B was 25.0% (p=.013). The influence level of a difference in the incidence rate was found to be 3.67 of the odds ratio.

CONCLUSIONS: It is considered that maintaining appropriate coronal alignment of device is important in long-term success after a cervical TDR.

Keywords: Cervical arthroplasty; Coronal alignment; Radiographic degeneration; Same segment degeneration; Adjacent segment degeneration; Total disc replacement

FDA device/drug status: Approved (Bryan artificial discs), Approved (Prestige LP artificial discs), Approved (Prodisc-C artificial discs).

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Introduction

Since Robinson and Smith introduced anterior cervical discectomy and fusion (ACDF) in 1955, it has been widely used as a method of surgical treatment for degenerative cervical disc disease. It is able to remove a disc or osteophyte protruding on the spinal cord via an anterior approach and can recover the loss of disc intervals using autogenous bone grafts or allografts, thereby enhancing stability.

Although ACDF is known as an effective surgical treatment for cervical degenerative disc disease; however, a problem has arisen in terms of the occurrence of complications such as disability and adjacent segment degeneration/disease (ASD) because the fusion damages normal biomechanics and accelerates degeneration of the surrounding structures. Radiographic changes such as osteophyte formation or ossification of anterior longitudinal ligament may occur in anterior cervical arthrodesis. This may also increase the necessity of eventual revision surgery [1–5]. To solve such problems, cervical artificial disc replacement (total disc replacement, TDR) has been performed in disc disease to reduce or prevent degenerative changes at surgical site and adjacent level by preserving motion and maintaining the height of the disc and foramen [6].

The primary goal of cervical disc replacement is to preserve motion and to maintain the height of the disc after removing a pathologically herniated disc. According to previous research on cervical disc replacement, such treatment maintains physiologic range of motion (ROM) and reduces the physical stress and the motion at the adjacent level to within the normal range. However, unlike ACDF, which aims at synostosis without being hugely influenced by the position of the grafted bone, it is true that insertion into the correct position is essential for cervical artificial disc to maintain the advantages of this instrument, and that accurate positioning of the implant at surgery reduces the load of the facet joint and other surrounding structures. On the other hand, inaccurate implant positioning or tilting of device may accelerate postoperative degenerative changes at surgical site and adjacent levels [7].

Recently, numerous studies have been conducted on the importance of radiographic parameters after a cervical disc replacement or ACDF [8]. Furthermore, most of the studies have mainly focused on sagittal alignment or ROM in the case of TDR [9]; on the other hand, there has been no research on what influence the coronal imbalance or tilting of the TDR device has on radiographic parameters. Thus, accurate positioning of insertion is necessary to maintain the advantages of the instrument for a long time. In this research, we planned to investigate the influences of coronal tilting of device on radiographic parameters, and especially, if there is a relation with the development of postoperative degenerative changes at surgical segment (surgical site degeneration or same segment degeneration [SSD]) and adjacent levels (ASD) in the patient group subject to TDR.

EVIDENCE & METHODS

Context
Several researchers have maintained that radiographic parameters of cervical disc arthroplasty (CDA) implants may alter biomechanical function and influence outcomes, as well as the risk of adjacent segment degeneration. Most research has focused on sagittal alignment of implants, however. The authors present their work regarding the influence of coronal alignment on adjacent segment degeneration following CDA.

Contribution
This study involved a heterogeneous group of 180 patients treated by one surgeon at a single center over a six-year period. Three different implants were used. Significant differences in coronal tilting of the CDA device were found for patients who developed radiographic degeneration at adjacent levels postoperatively as compared to those who did not.

Implications
This study presents novel findings regarding the influence of coronal radiographic alignment of CDA on the risk of adjacent segment degeneration. This work appears to be a retrospective review of prospectively collected data and, as such, is subject to selection and indication bias for the primary intervention as well as the choice of implant. There is also the potential for information bias to be present, as it seems the authors were aware of which patients developed adjacent degeneration before measurements were made. It is unclear if a repeat measurement method was used. Given these limitations, this work presents Level III evidence.

—The Editors

Materials and methods

This is a prospective study targeting 180 patients who underwent a single level TDR using the Bryan Artificial Disc Prosthesis (Medtronic Sofamor Danek, Memphis, TN, USA), Prestige (Medtronic Sofamor Danek, TN, USA), or Prodisc-C (Synthes Spine, Paoli, PA, USA) for single-level symptomatic cervical disc disease between January 2006 and January 2012 at a single center. Of the 180 patients, 96 patients received the Bryan disc, 51 patients received the Prestige LP, and 33 patients received the Prodisc-C. The Bryan disc group consisted of 54 male patients and 42 female patients, whereas the Prestige LP group consisted of 45 male patients and six female patients and the Prodisc-C group consisted of 18 male patients and 15 female patients. The C4–C5 level was treated in 52 patients, C5–C6 was treated in 78 patients, and C6–C7 was treated in 60 patients. Since January 2006, information on radiographic outcomes after cervical arthroplasty has been