

Clinical Study

Sagittal alignment as a predictor of clinical adjacent segment pathology requiring surgery after anterior cervical arthrodesis

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Abstract

BACKGROUND CONTEXT: Postoperative malalignment of the cervical spine may alter cervical spine mechanics and put patients at risk for clinical adjacent segment pathology requiring surgery.

PURPOSE: To investigate whether a relationship exists between cervical spine sagittal alignment and clinical adjacent segment pathology requiring surgery (CASP-S) following anterior cervical fusion (ACF).

STUDY DESIGN: Retrospective matched study.

PATIENT SAMPLE: A total of 122 patients undergoing ACF between 1996 and 2008 were identified, with a minimum of 2 years of follow-up.

OUTCOME MEASURES: Radiographs were reviewed to measure the sagittal alignment using C2 and C7 sagittal plumb lines, distance from the fusion mass plumb line to the C2 and C7 plumb lines, the alignment of the fusion mass, caudally adjacent disc angle, the sagittal slope angle of the superior end plate of the vertebra caudally adjacent to the fusion mass, T1 sagittal angle, overall cervical sagittal alignment, and curve patterns by Katsuura classification.

METHODS: A total of 122 patients undergoing ACF between 1996 and 2008 were identified, with a minimum of 1 year of follow-up. Patients were divided into groups according to the development of CASP (control/CASP-S) and by number/location of levels fused. Radiographs were reviewed to measure the sagittal alignment using C2 and C7 sagittal plumb lines, distance from the fusion mass plumb line to the C2 and C7 plumb lines, the alignment of the fusion mass, caudally adjacent disc angle, the sagittal slope angle of the superior end plate of the vertebra caudally adjacent to the fusion mass, T1 sagittal angle, overall cervical sagittal alignment, and curve patterns by Katsuura classification. Appropriate statistical tests were performed to calculate relationships between the variables and the development of CASP-S. No funds were received in support of this work. No benefits in any form have been or will be received from a commercial party related directly or indirectly to the subject of this article.

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The disclosure key can be found on the Table of Contents and at www.TheSpineJournalOnline.com.

The first and corresponding authors of this manuscript had full access to all the data in the study and take responsibility for the integrity of the data and the accuracy of the data analysis as well as the decision to submit for publication.

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RESULTS: The groups were similar with regard to demographic and surgical variables. Lordosis was preserved in 82% (50/61) of the control group but in only 66% (40/61) of the CASP-S group ($p=.033$). More patients with a straight curve pattern developed CASP-S. The distance from the C2 to the C7 plumb line and T1 sagittal slope angle were lower in the CASP-S group with C5–C6 fusions compared with the control group. Also, the distance from C5–C6 fusion mass to C7 plumb line and C7 sagittal slope angle were lower in the CASP-S group with C5–C6 fusions.

CONCLUSIONS: Our results suggest that malalignment of the cervical spine following an ACF at C5–C6 has an effect on the development of clinical adjacent segment pathology requiring surgery. © 2014 Elsevier Inc. All rights reserved.

Keywords:

Cervical spine; Sagittal alignment; Plumb line; Clinical adjacent segment pathology; Anterior fusion; T1 sagittal slope; Adjacent segment degeneration; ACDF; Sagittal angle; Kyphosis

Introduction

Clinical adjacent segment pathology may affect more than one fourth of all patients within 10 years after an anterior cervical arthrodesis [1,2]. The risk factors for clinical adjacent segment pathology include preexisting degeneration at the adjacent levels [1], previous cervical fusion [1], and sagittal cervical malalignment [3,4]. Malalignment of the cervical spine in the sagittal plane has been shown to increase adjacent segment disc pressures in cadaver models [5].

The sagittal alignment measured by C2–C7 Cobb angle does not describe where C2 lies relative to C7 [6]. The position of C2, relative to C7, in the sagittal plane is closely maintained [6–8]. The cervical plumb lines from the C2 in the longstanding radiographs were distributed in a narrow range (16.1 ± 11.6 mm) anterior to the center of C7 in a study with all 52 adult patients visiting for lumbar spine problem [6] and in a range (16.8 ± 11.2 mm) in a study with 100 asymptomatic volunteers [7]. The distance between cervical sagittal plumb lines from C2 and C7 may be another important element for cervical sagittal alignment. However, to our knowledge, there is no report about the relationship between the cervical sagittal alignment measured by the cervical sagittal plumb lines and clinical adjacent segment pathology in anterior cervical arthrodesis. The purpose of this study is to determine whether postoperative cervical sagittal alignment measured by the cervical sagittal plumb lines from C2 and C7 can be related to clinical adjacent segment pathology requiring surgery after anterior cervical arthrodesis.

Materials and methods

The Washington University in St. Louis institutional review board approved this study. The surgical records of the senior author were queried to identify adult patients undergoing anterior cervical discectomy or corpectomy and fusion between 1996 and 2008. Those patients undergoing surgery for nondegenerative disease (trauma, infection, tumor, deformity, inflammation) were excluded.

Clinical adjacent segment pathology is defined as degeneration at a segment adjacent to a fusion causing symptoms.

The cohort identified was divided into patients undergoing clinical adjacent segment pathology surgery (CASP-S) and those who did not (control). The CASP-S group was composed of patients who underwent secondary adjacent segment surgery because of symptoms concordant with adjacent segment pathology. Demographic data included age at surgery, gender, comorbidities including diabetes mellitus, smoking history, body mass index (BMI), and diagnosis. Follow-up was defined as the period after surgery in the control group and the time from index surgery to reoperation in the CASP-S group.

Surgical data collected included levels of surgery, number of fusion levels, and type of bone graft (autograft vs. allograft).

Radiographs at the final follow-up or before an additional surgery were assessed in each group to determine the distance between the C2 and the C7 sagittal plumb lines, distance from the plumb line of the fusion mass to C2 and C7 plumb lines, the sagittal slope angle of the superior end plate of the vertebra caudally adjacent to the fusion mass, T1 sagittal angle, caudally adjacent disc angle, alignment of the fusion mass, overall cervical sagittal alignment, and curve patterns, including kyphotic, straight, lordotic, and sigmoid.

Routine lateral radiographs were obtained using standard techniques. The patient stands upright, his or her head facing forward. The X-ray tube is positioned 72 inches from the patient. The C2 sagittal plumb line was drawn with a lateral gravity plumb line from the center of C2 (Fig. 1). The center of C2 was noted by the intersection of crossing diagonals of vertebral body of C2 on the lateral radiograph. The C7 sagittal plumb line was drawn with a lateral gravity plumb line from the center of C7 (Fig. 1). The plumb line of fusion mass was drawn with a lateral gravity plumb line from the center of fusion mass (Fig. 1). The center of C7 or fusion mass was noted by the intersection of crossing diagonals on the lateral radiograph. The distance between the plumb lines was measured as the shortest perpendicular distance between the two lines (Fig. 1). The caudally adjacent disc angle was measured as the angle between the caudal and cranial end plates of the disc just caudal to the fusion mass (Fig. 2). The sagittal slope angle of the superior end plate of the vertebra caudally adjacent to the fusion mass was measured as the angle

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