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Clinical Study

Risk factors for the development of adjacent segment disease following anterior cervical arthrodesis for degenerative cervical disease: Comparison between fusion methods

Ji-Soo Song [a], Byung-Wan Choi [b,*], Kyung-Jin Song [c]

[a] Department of Radiology, Chonbuk National University Hospital, Jeonju, Republic of Korea
[b] Department of Orthopedic Surgery, Inje University, Haeundae Paik Hospital, 1435, Jwa-dong, Haeundae-gu, Busan 612-030, Republic of Korea
[c] Department of Orthopedic Surgery, Chonbuk National University Hospital, Jeonju, Republic of Korea

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ABSTRACT

This study aimed to determine the risk factors for developing adjacent segment disease (ASDz) after anterior cervical arthrodesis for the treatment of degenerative cervical disease by analyzing patients treated with various fusion methods. We enrolled 242 patients who had undergone anterior cervical fusion for degenerative cervical disease, and had at least 5 years of follow-up. We evaluated the development of ASDz and the rate of revision surgery. To identify the risk factors for ASDz, the sagittal alignment, spinal canal diameter, range of motion of the cervical spine, number of fusion segments, and fusion methods were evaluated. The patients were divided into three groups according to the fusion method: Group A contained patients who had received autogenous bone graft only (53 patients), Group B contained patients who received autogenous bone graft and plate augmentation (62 patients), and Group C contained patients who underwent cage and plate augmentation (127 patients). ASDz occurred in 33 patients, of whom 19 required additional surgery. The risk of developing ASDz was significantly higher in male patients ($p = 0.043$), patients whose range of motion of the cervical spine was >30° ($p = 0.027$), and patients with spinal canal stenosis ($p = 0.010$). The rate of development of ASDz was not different depending on the number of fusion segments. The rate of development of ASDz was 41.5% in Group A, 9.6% in Group B, and 5.51% in Group C ($p = 0.03$). In patients who underwent anterior cervical arthrodesis for degenerative disease, the occurrence of ASDz was related to age, the cervical spine range of motion, and spinal canal stenosis. Additional plate augmentation for anterior cervical arthrodesis surgery can lower the rate of ASDz development.

1. Introduction

Since anterior cervical discectomy and fusion (ACDF) was first introduced by Smith and Robinson, it has been the standard of care for cervical degenerative disease [1]. However, arthrodesis of the spinal segments may lead to excessive stress at the unfused adjacent levels, and many studies have reported adjacent-level degenerative changes in 25–89% of patients after cervical arthrodesis [2–5]. The reported risk factors related to the development of adjacent segment degeneration are the number of fusion segments, the fusion level, age of the patient, combined underlying conditions, and previous degeneration. Eventually, this condition leads to adjacent segment disease (ASDz), which presents with new symptoms of radiculopathy or myelopathy [6–9].

Currently, various fusion materials and additional plate augmentations are widely used for anterior cervical arthrodesis. However, previous reports are limited and most studies have analyzed the results of anterior fusion using autografts only [7]. We performed this study to determine the risk factors for ASDz by analyzing patients with anterior cervical arthrodesis treated with various fusion methods for degenerative cervical disease.

2. Material and methods

2.1. Materials

We enrolled 242 patients who had undergone anterior cervical fusion for degenerative cervical disease and had at least 5 years of follow-up in this retrospective study. Exclusion criteria included injury due to trauma, a history of cervical spine surgery including procedures such as concomitant posterior decompression or fusion, and patient records with no clinical or radiological

* Corresponding author. Tel.: +82 51 797 0240; fax: +82 51 797 0249.
E-mail address: alla1013@naver.com (B.-W. Choi).

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follow-up data (Fig. 1). The study population consisted of 149 men and 93 women. The average patient age at the time of surgery was 54.9 years (range 32–82 years) and the average follow-up period was 83.7 months (range 62–119 months).

2.2. Methods

Careful physical and radiological examination, including plain radiography and MRI, were performed pre-operatively in all patients. Radiographic data were evaluated at 6 weeks and at 3, 6, 9, 12, and 18 months post-operatively and then annually by using anterior-posterior, lateral, and flexion/extension lateral plain radiographs. MRI was performed for evaluation in patients who presented with additional radiculopathy or myelopathic symptoms during follow-up. The development of ASDz was defined as nerve compression in the segments adjacent to the fusion level, confirmed radiologically through MRI or CT myelography, and was considered as a new diagnosis of radiculopathy or myelopathy. Data were collected from all 242 patients regarding the new diagnoses, time of onset of radiculopathy or myelopathy after the initial surgery, treatment methods, and clinical results.

2.3. Analysis of risk factors

We analyzed the development of ASDz and the rate of revision surgery due to ASDz. To identify the risk factors for ASD, the sagittal alignment, spinal canal diameter, range of motion (ROM) of the cervical spine, number of fusion segments, and the fusion method were evaluated and compared between ASDz and disease-free patients.

2.4. Radiological analysis

Radiological data were obtained for the following: sagittal alignment after surgery, spinal canal diameter, ROM, and the number of fusion segments. The cervical sagittal alignment and ROM were measured using the Cobb angle formed by the posterior margin of the C2 and C7 vertebral segments (Fig. 2). The spinal canal diameter was evaluated by measuring the Pavlov ratio. All measurements were undertaken using a picture archiving communication system (Marosis m-view, Infinitt, Seoul, Korea). Two blinded observers (K.J.S., B.W.C.) independently interpreted the radiological findings twice and the mean values were used. In order to verify the reliability of the measured values, the intra- and inter-observer correlation were checked using a Kappa coefficient test.

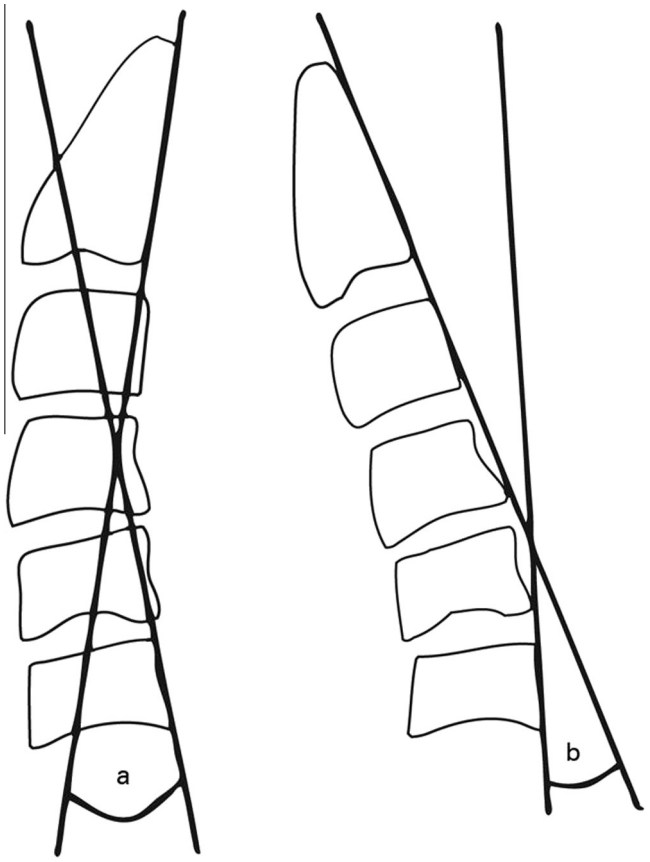

Fig. 2. Drawing showing measurement of range of movement of the cervical spine using functional radiographs and the Cobb angle, where range of movement = a + b.

2.5. Operation

General anesthesia was used on all patients. A standard Smith–Robinson method was used to expose the cervical spine. After complete decompression by removing the osteophytes and remnant

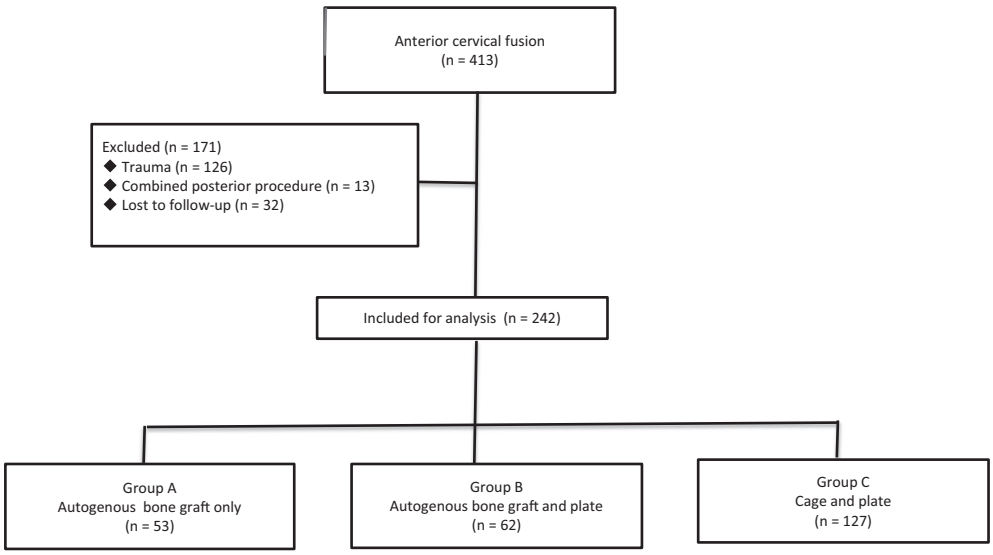

Fig. 1. Flow diagram showing patient allocation in the current study.