Journal of Clinical Neuroscience 33 (2016) 83–88

Contents lists available at ScienceDirect

Journal of Clinical Neuroscience

journal homepage: www.elsevier.com/locate/jocn

Clinical Study

Subsidence after single-level anterior cervical fusion with a stand-alone cage ☆

Jae-Young Park, Ki-Young Choi, Bong Ju Moon, Hyuk Hur, Jae-Won Jang, Jung-Kil Lee *

Department of Neurosurgery, Chonnam National University Medical School & Research Institute of Medical Sciences, 42, Jebongno, Dong-gu, Gwangju 501-757, Republic of Korea

ARTICLE INFO

Article history:
Received 6 November 2015
Accepted 17 January 2016

Keywords:
ACDF
Cage
Stand-alone
Subsidence

ABSTRACT

To investigate the risk factors for subsidence in patients treated with stand-alone anterior cervical discectomy and fusion (ACDF) using polyetheretherketone (PEEK) cages for single-level degenerative cervical disease. Seventy-seven consecutive patients who underwent single-level stand-alone ACDF with a PEEK cage between 2005 and 2012 were included. Subsidence was defined as a decrease in the interbody height of more than 3 mm on radiographs at the 1-year follow-up compared with that in the immediate post-operative image. Patients were divided into the subsidence and non-subsidence groups. The following factors were investigated in relation to the occurrence of subsidence: age, pre-operative overall cervical sagittal angle, segmental angle of the operated level, interbody height, cage height, cage devices and cage location (distance between anterior margin of the body endplate and that of the cage). The clinical outcomes were assessed with visual analog scale, modified Japanese Orthopedic Association score and neck disability index. Twenty-six out of the 77 (33.8%) patients had radiological signs of cage subsidence. Solid fusion was achieved in 25 out of the 26 patients (96.2%) in the subsidence group and in 47 out of the 51 patients (92.2%) in the non-subsidence group. More than 3 mm distance between anterior margin of the vertebral body and that of the cage was significantly associated with subsidence ($p < 0.05$). However, subsidence did not correlate with fusion rate or clinical outcomes. Cage location was the only significant risk factor. Therefore, cage location should be taken into consideration during stand-alone ACDF using PEEK cages.

1. Introduction

Anterior cervical discectomy and fusion (ACDF) is one of the most commonly performed procedures for degenerative cervical disease [1]. The goals of ACDF are to decompress the spinal cord and nerve roots and to provide bone fusion with cervical lordotic curvature [2–4]. Single-level ACDF with autologous bone can provide a high successful fusion rate (>90%) and neurologic and symptomatic improvement in 70–90% of the treated patients [2,3,5]. The most common complications is donor site pain after the iliac crest harvest with an incidence of 20–30% [6–8]. Beside the complications, other limitations include a second operative procedure, increased surgical time and insufficient amount of graft material available. To avoid the morbidity of graft harvesting, freeze-dried allograft has been used. However, the allograft has several disadvantages such as immunologic reaction, graft fracture, delayed union and nonunion. In addition, insufficient successful fusion rate, graft collapse and kyphotic change are the other disadvantages [8].

Synthetic interbody cages such as polyetheretherketone (PEEK) cages have been developed to achieve immediate stability and to allow bony ingrowth through and around the cage. The use of stand-alone ACDF with cages has increased in popularity recently. Controversy remains as to whether anterior plating is needed in one-level ACDF. Although stand-alone ACDF using PEEK cages can provide favorable outcomes, many surgeons have mentioned about the development of cage subsidence which may cause segmental kyphosis, acceleration of adjacent segment disease, and a decreased rate of fusion [9–12]. Recently, favorable results have been reported by using PEEK cages alone for the treatment of one- or two-level ACDF [13,14]. In our institution, stand-alone ACDF using a PEEK cage was performed without additional plate fixation as a routine procedure since 2005. In this study, we investigated several factors associated with subsidence in the treatment of single-level degenerative cervical disease.

☆ This study was supported by a grant (CRI13902-21) from Chonnam National University Hospital Biomedical Research Institute.

* Corresponding author. Tel.: +82 62 220 6602; fax: +82 62 224 9865.
E-mail address: jkl@chonnam.ac.kr (J.-K. Lee).

http://dx.doi.org/10.1016/j.jocn.2016.01.042
0967-5868/© 2016 Elsevier Ltd. All rights reserved.

2. Materials and methods

2.1. Study population

A retrospective study was performed between February 2005 and December 2012 at one institute. The clinical and radiological data were collected in patients who underwent ACDF with a PEEK cage for degenerative cervical disease. Indications for surgery included radiculopathy, myelopathy or a combination of the two due to the nerve root or spinal cord compression. Patients with recent infection, surgery for prior cervical lesion, osteoporosis, and cervical instability were excluded from this study. Seventy-seven consecutive patients who have been followed for more than 1 year after surgery were enrolled (52 males and 25 females).

2.2. Surgical procedure

The patient was positioned in a neutral supine position. Pre-operative fluoroscopy was used to confirm the incision site and adequate visualization of the index level. A standard transverse skin incision was performed over the affected level on the medial side of the sternocleidomastoid muscle to expose the prevertebral space. Intraoperative fluoroscopy was used to confirm proper spinal alignment and localization. Standard anterior cervical discectomy was performed in all patients. Under the microscope, the protruded disc compressing the roots or spinal cord was totally removed after adequate distraction. The posterior osteophytes were removed with a Kerrison punch, and the superior and inferior vertebral body end plates were decorticated. Bone fragments obtained during resection were collected for grafting. Sufficient decompression was confirmed by checking the dura mater after removal of the posterior longitudinal ligament.

The PEEK cage was packed with putty form of demineralized bone matrix (DBM) such as Grafton (Osteotech, Inc., Shrewsbury, NJ, USA) or DBX (MTF, Edison, NJ, USA) mixed with local autologous bone chips obtained from anterior and posterior bony spur, and inserted into the disc space. Two types of cage were used; Cornerstone (Medtronic, Memphis, TN, USA) of the lordotic type and Solis (Stryker Spine, South Allendale, NJ, USA) of the non-lordotic type. The implant is available in three heights of 5, 6, or 7 mm with an internal anteroposterior width of 14 mm. The cage is radiolucent but titanium markers aid in localization and identification of the correct position on plain radiographs. Immediately after cage insertion, a fluoroscopic view was obtained to check for the proper positioning of the cage. All patients were kept in a cervical collar for 4 weeks post-operatively, and early ambulation was encouraged.

2.3. Outcome assessment

For the radiological assessment, anteroposterior (AP), lateral and flexion–extension radiographs were obtained immediately after surgery and at intervals of 3, 6 and 12 months after surgery and then annually. The overall cervical sagittal angle (CSA), cage height, interbody height, cage location and segmental angle (SA) of the treated level were measured on neutral lateral radiographs. The overall CSA was measured as the angle formed by the lines drawn parallel to the lower endplates of C2 and C7 on a neutral simple radiograph. The SA was measured as the angle formed by the lines drawn parallel to the superior margin of the upper vertebral body and the inferior margin of the lower vertebral body of the treated level on a neutral simple radiograph. Cage height was evaluated by measuring the distance from the anterior superior margin of the cage to the anterior inferior margin of the cage. Interbody height was measured as the total vertical height of the two vertebral bodies of the treated level. Cage location was defined as the distance from the anterior end of endplate of the vertebral body to the anterior margin of the cage (Fig. 1).

The fusion status was assessed using plain lateral flexion and extension radiographs obtained 12 months after the surgery. Fusion was assessed by examination of trabecular continuity, bone bridging across the disc space at the anterior and/or posterior cortex, and a hazy interface between the cage and the vertebral endplate. If there was less than two degrees of motion at the fusion site or less than 2 mm gap in the interspinous distance on the flexion and extension radiographs, stability was assumed. Subsidence was defined as a greater than 3 mm reduction in the interbody height on the immediate post-operative and 1-year follow-up radiographs or when the cage had clearly penetrated the vertebral endplate.

The clinical outcomes were assessed with visual analog scale (VAS), modified Japanese Orthopedic Association (mJOA) score and neck disability index (NDI). Each clinical measurement was obtained before surgery, immediately after surgery, and at the last follow-up. The pre-operative and follow-up VAS scores for axial and radicular pain were assessed (score range 0–10). The mJOA score includes motor function of upper and lower extremities, sensory function of upper and lower extremities, and bladder function. The NDI was used to assess the neck pain and disability.

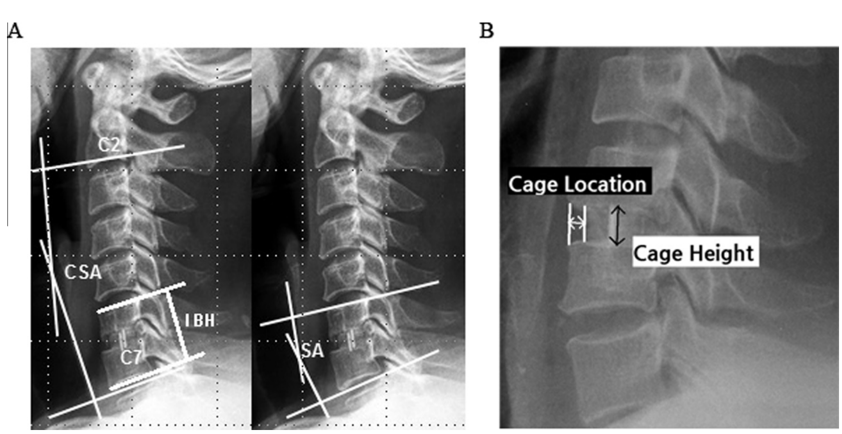

Fig. 1. (A) Cervical sagittal angle (CSA): lines drawn parallel to the lower endplates of C2 and C7, segmental angle (SA): lines drawn parallel to the superior margin of the upper vertebral body and the inferior margin of the lower vertebral body of the treated level. Interbody height was measured as the total vertical height of the two vertebral bodies of the treated level. (B) Cage height (Black arrow and text), evaluated by maximal diameter from the superior margin to the inferior margin, and cage location (white line and text), distance measured from anterior margin of the body endplate to that of the cage.