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ABSTRACT

Background

Anterior cervical corpectomy provides the most direct and thorough surgical approach for anterior decompression when spinal cord compression is found directly behind the vertebral body. However, anterior cervical fusion has been shown to be associated with the development of new degenerative changes at levels immediately adjacent to the fused segments. The incidence of adjacent segment disease (ASD) following anterior cervical corpectomy has not been widely reported. We set out to determine the incidence of clinical ASD following anterior cervical corpectomy.

Methods

We retrospectively reviewed all available medical charts and radiographic studies of all cases of anterior cervical corpectomy performed at the Barrow Neurological Institute over a 4-year period with a minimum 24-month follow-up. Factors assessed included the success of arthrodesis, the presence of degenerative changes on serial follow-up radiographs, and the development of new neurological symptoms.

Results

Seventy-six patients met the criteria for inclusion: 54 had undergone a 1-level corpectomy, 18 underwent a 2-level corpectomy, and 4 underwent a 3- or 4-level corpectomy. Arthrodesis was performed with either allograft or autograft and anterior cervical plating. All patients achieved successful fusion. Follow-up was available for a minimum of 2 years in all cases, with a mean length of 3.6 years. Sixteen patients (21%) eventually developed radiological and clinical evidence of degenerative changes at adjacent levels. In 10 of 11 patients who developed clinical symptoms within 2 years, the changes represented progression of pre-existing, asymptomatic degenerative disease. Five patients developed degenerative changes more than 5 years after surgery; these were all associated with an unrelated new insult to the cervical spine such as trauma.

Conclusions

Anterior cervical corpectomy with fixation can accelerate degenerative changes identified preoperatively at adjacent, asymptomatic levels of the cervical spine.

Level of Evidence

Retrospective cohort study (level 2b).

Key Words: Cervical spine spondylosis, anterior cervical fusion, corpectomy, adjacent segment disease. *SAS Journal.* **Winter 2008. 2:23–27.** DOI: SASJ-2007-0108-RR

INTRODUCTION

Anterior compressive lesions of the cervical spine are ideally addressed via an anterior approach. Anterior cervical corpectomy provides the most direct and thorough surgical approach for anterior decompression when spinal cord compression is found directly behind the vertebral body. Indications include degenerative disorders,[1-3] neoplasms,[4-5] trauma,[6-7] infectious disorders,[8] or correction of either degenerative or iatrogenic kyphosis.[9-12] The procedure has enjoyed excellent clinical results, in terms of neurological outcomes, and success of arthrodesis and stabilization.[2,9,13-16]

Fusion of the cervical spine has biomechanical consequences. Loss of mobility at one functional spinal unit increases the load sustained by the remaining units.[17-18] Anterior cervical fusion has been shown to be associated with the development of new degenerative changes at levels immediately adjacent to the fused segments.[19-24] However, the frequency, cause, and clinical significance of these adjacent segment changes remain controversial. Different rates of adjacent segment disease (ASD) have been reported in the literature[19,21-23,25-27] and have varied according to the definition of ASD, whether radiographic or clinical features were used to identify cases, and the length of follow-up.

The incidence of ASD following anterior cervical corpectomy has not been widely reported.[28] Corpectomy might be expected to produce even more rapid degeneration because it creates a longer lever arm and involves a minimum of 2 intervertebral discs. In one study, short-term radiographic follow-up with magnetic resonance imaging found accelerated degenerative change at levels adjacent to the fused segment in 75% of patients (N=106) who had undergone 1- or 2-level corpectomy.[19] We describe the incidence of clinical ASD following anterior cervical corpectomy and fusion.

MATERIALS AND METHODS

Over a 4-year period, more than 200 patients underwent anterior cervical corpectomy with fusion at the Barrow Neurological Institute (BNI) of St. Joseph's Hospital and Medical Center, Phoenix, Arizona, for the treatment of a variety of conditions, by the senior author (V.K.S.). Our patient cohort included 76 patients with at least 24 months clinical and radiographic follow-up. Where preoperative imaging showed disease at multiple levels, the clinical findings determined the extent of surgery, with only symptomatic levels being addressed.

A standard right anterolateral approach was used, with the decompression carried out in the usual fashion.[13] Anterior internal fixation was performed using iliac autograft or fibular allograft, and plating with one of the following systems: Atlantis (Medtronic Sofamor Danek, Memphis, Tennessee), Codman (Johnson & Johnson Professional Inc., Raynham, Massachusetts), Orion (Medtronic Sofamor Danek), or Synthes (Synthes Spine, Paoli, Pennsylvania).

Postoperatively, computed tomography scans were obtained to assess the extent of decompression and fusion, and the placement of the graft, plate, and screws. All patients were followed clinically and radiographically, with neutral and dynamic (flexion-extension) cervical radiographs at 3–6 weeks, 6 months, and then on a yearly basis after surgery.

RESULTS

This retrospective cohort comprised 50 males and 26 females, with a mean age of 54 years (range 11–82). Myelopathy was the presenting condition in 48 patients (63%); 19 (25%) had a radiculomyelopathy, and 9 (11%) a pure radiculopathy. The primary indication for surgery was degenerative spondylosis (45 patients). Other indications included trauma (21 patients), ossification of the posterior longitudinal ligament (6 patients), neoplasm (3 patients), and rheumatoid arthritis (1 patient).

A 1-level corpectomy was performed on 54 patients. Two levels were addressed in 18 patients, 3 levels in 3 patients, and 1 patient had a 4-level corpectomy. Corpectomies were most frequently performed at C5, followed by C4, C6, C3, and C7. During 18 procedures, discectomies at levels other than the level of the corpectomy were indicated. Autologous iliac crest graft was used in 58 patients and fibular allograft in the remaining 18. There was no significant difference in the rate of adjacent segment disease between patients who received autograft or those who received allograft (chi-square 1.403, df = 1, $P > .10$). All patients in this series achieved solid arthrodesis; there were no cases of pseudoarthrosis or hardware failure. Patients treated with a 3- or 4-level corpectomy were placed in a halo-thoracic vest for 3 months following surgery.

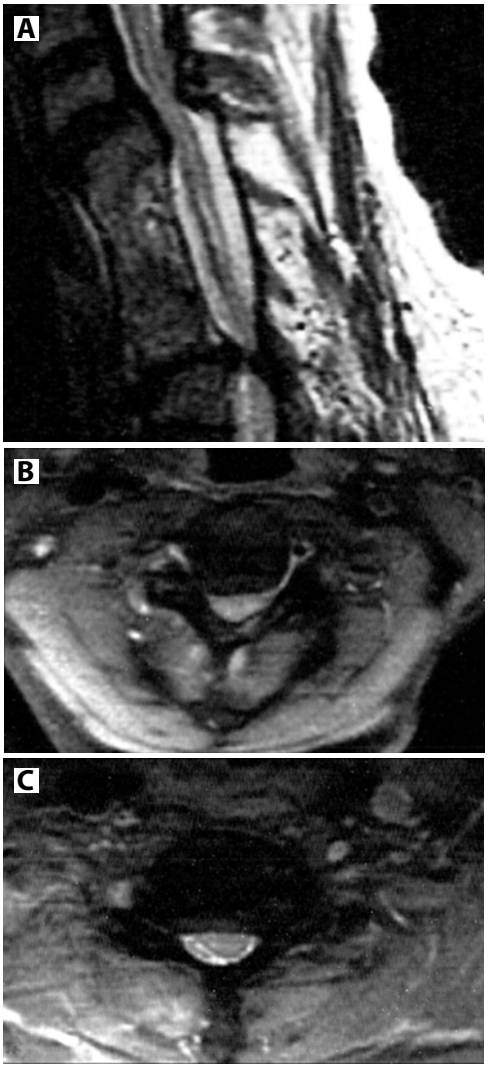
Patients were followed for a minimum of 2 years, with a mean length of follow-up of 3.6 years. ASD was identified clinically by the development of new symptoms of radiculopathy and/or myelopathy. These ultimately developed in 16 of the 76 patients (21%). Radiological findings in these patients with spondylosis included uncovertebral osteophytes, disc herniation, narrowing of the disc space, or new radiographic instability (Figures 1 and 2). The C6-7 level was most commonly involved (n=8); C5-6 was affected in 4 patients, C3-4 in 2 patients, and 1 patient had degenerative changes at C2-3 and C4-5. The levels superior and inferior to the fused segment were affected with equal frequency (8 cases of each). Thirteen of the 16 patients with ASD had undergone a single-level corpectomy. The rate of ASD for single-level corpectomy was therefore 24% (13/54). There was no significant correlation between the length of the construct, in terms of the number of levels involved, and the likelihood of developing ASD.

Figure 1.

Lateral radiographs of one patient showing ASD at both adjacent levels to the fusion.

Eleven of the 16 patients who developed ASD did so within 2 years of the corpectomy and fusion. Ten of 11 (91%) patients had identifiable degenerative changes on the preoperative X-rays, at levels that were not incorporated into the construct because they were asymptomatic at the time of the initial surgery. Five patients presented with clinically significant ASD more than 2

Figure 2.



MRI images of ASD at both adjacent levels to the fusion. (A) Sagittal images demonstrating ASD at C3-C4 and C6-C7, (B) Axial image at C3-C4, and (C) C6-C7.

years following the initial surgery. These patients all described a minor injury to the spine, such as a fall or whiplash injury, which was followed by recurrence of symptoms.

DISCUSSION

Our findings suggest 2 different groups of patients with symptomatic ASD, with differing etiologies. The first group developed changes early, within the first 2 years postoperatively, and had radiographic evidence of asymptomatic degeneration at adjacent levels at the time of initial presentation. The remaining patients, those who developed ASD symptoms after a longer period (> 60 months), were likely to have had a second self-reported insult to the spine in the form of trauma. Widely quoted studies suggest that the risk of ASD is cumulative.[23] A survivorship analysis by Hilibrand et al. in patients with anterior cervical discectomy and fusion (ACDF) suggests that the risk of ASD persists for years, and that longer follow-up periods increase the detection of clinically significant ASD.[23] This study indicates, however, that the highest risk of developing ASD after corpectomy may occur in the first 2 years following surgery.

Corpectomy is indicated if the vertebral body itself is diseased or is producing compression of the spinal cord. However, in patients with multilevel degenerative cervical disc disease, it is controversial whether multilevel discectomy or corpectomy should be performed. Hilibrand et al. reported that fusion rates were significantly better with corpectomy and strut grafting than with multilevel interbody fusions.[29] Swank et al. described a 10% rate of nonunion following 1-level corpectomy, as compared to a 36% rate of nonunion among 2-level ACDF.[16] In contrast, Wang et al. reported no significant difference in fusion rates, complications, or clinical outcomes between single-level corpectomy and 2-level adjacent discectomy, both with anterior cervical plate fixation.[30] Corpectomy offers a theoretical advantage by reducing the number of graft-host bony interfaces that need to achieve fusion; however, this is offset by potentially greater morbidity and a higher rate of graft dislodgment.[29,31]

Anterior cervical fixation, whether with corpectomy or ACDF, carries biomechanical consequences. Fusion increases stress and mechanical demand on the adjacent nonfused segments.[18,24] In an in vitro study, Panjabi et al. found that the application of an external fixator to the cervical spine decreased intervertebral motion, with flexion, extension, and torsional neutral zones being particularly affected. Biomechanical analysis in cadaveric specimens subjected to fixation and anterior cervical plating demonstrated increased intradiscal pressures and increased segmental motion at adjacent levels during normal ranges of motion.[32] In vivo, fusion has been shown to alter the likelihood and type of acute traumatic instability at adjacent levels in the cervical spine[33] and has been implicated in the progression of degenerative cervical disc disease. Radiographic evidence of degeneration at levels above and below an ACDF has been reported in between 0% and 81% of cases,[19,21,34-35] with such changes often becoming evident within 12–24 months following surgery.[18,36] While several investigators have failed to find correlations between such changes on imaging and clinical symptomatology,[34,37-39] a large Kaplan-Meier survivorship analysis found that the annual risk of clinically significant ASD following ACDF was relatively constant at 2.9%, with cumulative risk at 10 years being 26%.[23] Pre-existing degenerative disease appears to be the major risk factor for ASD identified to date. Matsunaga et al. studied 96 patients following ACDF and demonstrated increased strain at the adjacent-level intervertebral discs, particularly in cases where degenerative changes were found at the adjacent levels preoperatively.[18] Eighty-five percent of discs showing abnormal strain went on to herniate during follow-up, indicating the clinical relevance of the altered biomechanics.[18] Age may be

a relevant factor to consider in assessing the risk of ASD, as it relates to both tissue characteristics and expected lifespan; however, we were unable to provide any correlation with this relatively small sample covering a wide age range.

At the time of initial surgery, all symptomatic levels should be addressed in patients whose presentation is clinically compatible with multilevel disease. However, it is clear that multilevel procedures have higher complication rates and lower fusion rates than single-level procedures.[30] It is debatable whether additional asymptomatic degenerative levels should be incorporated into procedures already involving a corpectomy. Our single-level corpectomy patients had a higher rate of ASD than patients with multilevel corpectomies (24% vs. 14%, though this was not statistically significant); this result may simply reflect the fact that levels with similar amounts of degeneration were left unfused adjacent to the corpectomy in single-level cases, but were included in the construct in multilevel cases.

Without a randomized trial design, it is not possible to assess whether the early recurrence of symptoms in corpectomy patients represents acceleration of these incipient degenerative changes or simply the natural history of cervical spondylosis. However, the observed rate of ASD in our patients during the first 2 years was higher than that expected based on previous reports.[23] Our results suggest that incipient degenerative changes at adjacent levels that are not addressed at the time of initial surgery may subsequently progress to symptomatic disease. This, however, must be compared to the increased risk of non-fusion and worsened biomechanics associated with performing a longer initial fusion construct. Surgeons need to consider the risks of ASD when contemplating the incorporation of additional levels, weighing the relative benefits against the lower fusion rates associated with multilevel anterior fusions.

The patients reviewed in this series represent less than half of the total number of corpectomies with fusion performed at the BNI during the time period considered. The BNI receives many out-of-state and out-of-country referrals who do not return for follow-up but rather are managed in their local area. This may have led us to overestimate the incidence of ASD because patients with recurrent symptoms may have been more likely to return. Alternately, some cases may have been missed, if symptoms recurred several years following the original surgery and patients did not return to BNI for further assessment.

CONCLUSION

Anterior cervical corpectomy and fusion is associated with progression of degenerative disease at spinal levels adjacent to the fused segment. Clinical and radiographic changes of adjacent segment disease typically became evident within 2 years in this series of patients.

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