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The Spine Journal 13 (2013) 823–829

THE SPINE JOURNAL

Review Article

Anterior cervical plating technique to prevent adjacent-level ossification development

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Received 21 January 2011; revised 26 November 2012; accepted 7 March 2013

Abstract

BACKGROUND CONTEXT: The proximity (<5 mm) of the plate to the adjacent disc space is known to be a critical risk factor for adjacent-level ossification development (ALOD). As plates provide many advantages including higher fusion rates and improved alignment, their use will continue. Instead, it is necessary to modify the plating techniques to minimize this complication.

PURPOSE: To determine if our newer plating technique decreases the incidence of ALOD after anterior cervical plating.

STUDY DESIGN: Retrospective matched cohort analysis of preoperative and postoperative radiographic data.

PATIENT SAMPLE: One hundred patients were classified into two groups; conventional (C) and new (N) plating techniques. The control group (Group C) was matched to the study group (Group N) in a 1:1 fashion using matching criteria of age (within 5 years), gender, number of fusion levels, and comorbidities, including diabetes and tobacco use.

OUTCOME MEASURES: The lateral plain X-rays of cervical spine taken at postoperative 6 months and 2 years were used for analysis.

METHODS: In Group N, the cranial and caudal screws were started at the anterior end plate corners and angled away from the end plates so as to use the shortest possible plate and maximize the distance to the adjacent end plates. Group C was the historical control using a longer plate with more orthogonal screw angulation. On postoperative 6-week lateral films, the distances from the tip of the plate to both cranial and caudal adjacent discs (plate-to-disc distances) were measured. Based on the postoperative 2-year radiographs, the incidence of ALOD was determined, and the severity of ossification was classified on a scale ranging from Grade 0 (no ossification) to Grade 3 (complete bridging).

RESULTS: Mean plate-to-disc distances in Group N were significantly longer at both cranial and caudal adjacent levels than those in Group C ($p<.001$). The incidence of ALOD was significantly lower in Group N than in Group C, both at the cranial adjacent disc spaces (42% vs. 72%) and caudal adjacent disc spaces (20% vs. 42%) ($p<.05$). Severe ossification (Grade 2 or greater) also developed less frequently in Group N at cranial and caudal levels (6% vs. 20%, respectively; $p<.05$).

FDA device/drug status: Not applicable.

Author disclosures: ***D-HL:*** Nothing to disclose. ***J-SL:*** Nothing to disclose. ***J-SY:*** Nothing to disclose. ***WC:*** Nothing to disclose. ***LPZ:*** Nothing to disclose. ***KDR:*** Royalties: EBI/Biomet (F), Osprey (C), Medtronic Sofamor Danek (G); Stock Ownership: Osprey (10 shares, 0%), Expanding Orthopedics (approximately 10,000 shares, 1%, no viable products), Spineology (B, <1%), Spinal Kinetics (C, <1%), Nexgen Spine (B, <1%), Amedica (B, <1%), Vertiflex (B, <1%), Benvenue (C, <1%), Paradigm Spine (B, <1%), PSD (B, <1%); Board of Directors: Korean Association of Spinal Surgeons (none), Cervical Spine Research Society (none); Relationships Outside the One-Year Requirement: Medtronic (08/2009, Consulting, F).

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1529-9430/$ - see front matter
http://dx.doi.org/10.1016/j.spinee.2013.03.009

CONCLUSIONS: The new technique of using a shorter plate with longer angulated screws resulted in significantly reduced incidence and severity of ALOD.

Keywords: Adjacent-level ossification development; Anterior cervical plating technique; Anterior cervical fusion

Introduction

Anterior adjacent-level ossification development (ALOD) is thought to be a type of heterotopic ossification, rather than a secondary degeneration developing at the disc adjacent to a fused level. This assumption is based on several studies showing that the ossification occurs in soft tissues that do not form bone under normal conditions. More importantly, this bone matures within the first 2 years after surgery, in contrast to adjacent segment degeneration, in which osteophytic bone and disc degeneration gradually increase over time [1–3]. Adjacent-level ossification development occurs commonly after anterior cervical arthrodesis with plating [4–7], and its low incidence in unplated fusions indicates that plating techniques contribute to its development [2]. Previously, we demonstrated that the proximity (<5 mm) of the plate to the adjacent disc space is a critical risk factor of ALOD [1,8]. Because plates do provide many advantages, including higher fusion rates and improved alignment [9–13], it will be important to develop better plating techniques to minimize this complication. In this study, we sought to determine if keeping the plate as short as possible decreases ALOD.

Materials and methods

Study design

Since 2003, we have been using an anterior cervical plating technique to prevent ALOD on the basis of our own clinical experiences and preceding studies. We selected 50 consecutive patients who underwent surgery by the senior (last) author (KDR) using a conventional plating technique between January 2000 and August 2001 and met the inclusion/exclusion criteria as the control group (Group C). The inclusion criteria were the following: (1) anterior cervical discectomy/corpectomy of three or less levels and fusion with plating, (2) age 20 years or older, (3) solid fusion, and (4) minimum 2-year follow-up. Exclusion criteria were the following: (1) previous anterior or posterior cervical spine surgery, (2) fusion extending proximally to C2 or distally to T1, (3) additional cervical spine surgery within 2 years, (4) preexisting anterior osteophytes adjacent to the index level, or (5) nondegenerative disease (trauma, infection, tumor, and inflammatory diseases).

Group C was matched to a study group (Group N) in a 1:1 fashion using matching criteria of age (within 5 years), gender, number of fusion levels, and comorbidities, including diabetes and tobacco use. Patient selection and all the analyses were performed independently by two experienced spine surgeons who were not involved in the care of the patients.

Plating technique

The basic concept of the new plating technique is to keep the cranial and caudal ends of the plate away from the adjacent discs as much as possible. To accomplish this, the most cranial and caudal screw holes are made at the corners immediately adjacent to their respective operative-level end plate, and the shortest plate that fits these pilot holes is selected. The screw insertion angles are directed away from the end plates, allowing for longer screws than the previous conventional technique (Fig. 1, Left). We used fixed angle screws cranially and variable angle screws caudally to limit subsidence to the caudal vertebra as the caudal vertebra is taller than the cranial.

The conventional plating technique consisted of drilling pilot holes on the anterior surface of the vertebral bodies with screws placed parallel to the end plates. Although we tried to place the screws as close to the end plate as possible, this technique required wider dissection of the anterior longitudinal ligament and longus colli muscles around the operative disc level compared with our new technique (Fig. 1, Right). Regardless of the technique, we preoperatively measured the anteroposterior diameter of each vertebra and strived to place the longest possible screws.

Radiological parameters for comparison between Group N and Group C

The distances between the tips of the plate and the caudal and cranial adjacent discs (plate-to-disc distance) were measured on the postoperative 6-week lateral radiograph of the cervical spine. We also measured the screw-to-end plate angle at the most cranial and caudal vertebral bodies of the fused segments. We gauged the height of vertebral body that remained after end plate carpentry. The anteroposterior diameter of the cranial/caudal end vertebrae and the real length of the screws placed in those vertebrae were measured. Screw-to-body ratio was calculated by dividing the screw length by vertebral diameter (Fig. 2).

The ALOD severity on postoperative 2-year lateral films was classified into four grades using the previously described grading system: Grade 0 (no ALOD formation), Grade 1 (ALOD extends across less than 50% of the disc space), Grade 2 (ALOD extends greater than or equal to