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International Journal of Spine Surgery 7 (2013) e101–e108

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Effects on inadvertent endplate fracture following lateral cage placement on range of motion and indirect spine decompression in lumbar spine fusion constructs: A cadaveric study

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Abstract

Background: The lateral transpsoas approach to interbody fusion is gaining popularity. Existing literature suggests that perioperative vertebra-related complications include endplate breach owing to aggressive enedplate preparation and poor bone quality. The acute effects of cage subsidence on stabilization and indirect decompression at the affected level are unknown. The purpose of this study was to compare the kinematics and radiographic metrics of indirect decompression in lumbar spines instrumented with laterally placed cages in the presence of inadvertent endplate fracture, which was determined radiographically, to specimens instrumented with lateral cages with intact endplates.
Methods: Five levels in 5 specimens sustained endplate fracture during lateral cage implantation followed by supplementary fixation (pedicle screw/rod [PSR]: n = 1; anterolateral plate [ALP]: n = 4), as part of a larger laboratory-based study. Range of motion (ROM) in these specimens was compared with 13 instrumented specimens with intact endplates. All specimens were scanned using computed tomography (CT) in the intact, noninstrumented condition and after 2-level cage placement with internal fixation under a 400-N follower load. Changes in disc height, foraminal area, and canal area were measured and compared between specimens with intact endplates and fractured endplates.
Results: Subsidence in the single PSR specimen and 4 ALP specimens was 6.5 mm and 4.3 ± 2.7 mm (range: 2.2–8.3 mm), respectively. ROM was increased in the PSR and ALP specimens with endplate fracture when compared with instrumented specimens with intact endplates. In 3 ALP specimens with endplate fracture, ROM in some motion planes increased relative to the intact, noninstrumented spine. These increases in ROM were paralleled by increase in cage translations during cyclic loading (up to 3.3 mm) and an unpredictable radiographic outcome with increases or decreases in posterior disc height, foraminal area, and canal area when compared with instrumented specimens with intact endplates.
Conclusions: Endplate fracture and cage subsidence noted radiographically intraoperatively or in the early postoperative period may be indicative of biomechanical instability at the affected level concomitant with a lack of neurologic decompression, which may require revision surgery.

Keywords: Lumbar interbody fusion; Lateral transpsoas approach; Endplate fracture; Indirect decompression; Stability

Introduction

Segmental stabilization and spine fusion may be a necessary adjunct to neurologic decompression in the degenerated spine. According to a 2005 study,[1] fusion procedures in the US represented > 50% of all lumbar spine operations excluding those for disc herniation. The same study reported

This study was supported by a research grant from NuVasive, Inc. (San Diego, CA).

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2211-4599
http://dx.doi.org/10.1016/j.ijsp.2013.09.001

that the number of lumbar fusions increased 230% among patients 60 years and older from 1988–2001. Increases in fusion surgery were also apparent in patients in their 40s and 50s (180%) and 20s and 30s (120%). These data, along with the increasing size of the elderly population,[2,3] suggest that interbody fusion will continue to be a mainstay surgical intervention for alleviation of neurologic symptoms secondary to degenerative spine conditions.[4]

Traditionally, fusion has been accomplished via open approaches[5] that include anterior lumbar interbody fusion (ALIF),[6,7] posterior lumbar interbody fusion,[8] and transforaminal lumbar interbody fusion.[9,10] Complications associated with open spine fusion procedures have been described and include infection, visceral injury, instrumentation malposition, and neurologic deficits.[5,6,9–13] To mitigate these morbidities, minimally invasive surgical (MIS) approaches have been described, and include endoscopic ALIF,[14] mini-ALIF,[15] and MIS transforaminal lumbar interbody fusion.[9] The minimally invasive retroperitoneal transpsoas approach has been recently introduced and is gaining popularity. By virtue of the approach, an access surgeon is not necessary, and the need to mobilize the great vessels is obviated, which minimizes the potential for visceral and vascular complications. This advantage has been realized, with a recent clinical report of a zero incidence of intraoperative visceral injury.[16] Biomechanically, the technique allows a large discectomy and placement of a large interbody spacer that spans the dense apophyseal ring, promoting a large surface area for fusion. Authors in favor of the technique report that disc height (DH) restoration and correction of alignment can be better achieved through the ligamentotaxis allowed by intact anterior and posterior longitudinal ligaments.[17,18]

Clinical, radiographic, and biomechanical studies evaluating this technique have reported promising results regarding indirect decompression in patients while conferring stability to the affected segment(s).[17,19] Despite these findings, complication reports are minimal.[20–23] Rodgers et al.[16] reported an overall complication rate of 6.2% (37/600), with 6 vertebra-related complications including endplate fracture and vertebral fracture/subsidence. To our knowledge, the acute effects of endplate breach and cage subsidence on biomechanical stability and indirect decompression at the affected level are unknown. The purpose of this study was to report the kinematic and radiographic effects of 5 endplate fractures sustained during placement of the interbody device and documented on postinstrumentation radiographs and computed tomography (CT) scans as part of larger biomechanical and radiographic study in human cadaveric lumbar spines.

Materials and methods

Endplate fracture specimens

A total of 36 L3-L4 (n = 18) and L4-L5 (n = 18) lumbar levels were instrumented with 18-mm wide cages (CoRoent XL; NuVasive Inc., San Diego, California) in 18 (n = 18) human cadaveric spines. Lateral discectomy was performed to remove sufficient disc material and prepare the vertebral endplates similar to clinical practice. The cages were made from polyetheretherketone, and the lateral length and height dimensions were determined by anatomy. The anterior and posterior longitudinal ligaments and anterior annulus were left intact, such that when the large footprint cage was inserted into the disc, the ligaments stretched owing to distraction. A total of 9 (n = 9) spines were randomly allocated to receive (1) lateral plate (XLP Plate; NuVasive) at each level or (2) bilateral pedicle screws (SpheRx and DBR II; NuVasive) at each level. Lateral plate and posterior pedicle screw/rod (PSR) instrumentation was facilitated with fluoroscopy and all procedures were performed by board-certified spine surgeons experienced with the lateral approach technique.

Of the n = 36 implanted lumbar levels, 5 (n = 5; 13.9%) levels in 5 specimens sustained inadvertent endplate fracture and apophyseal ring violation (Fig. 1) during cage placement (inferior: n = 4, 80%; superior: n = 1, 20%) as documented via lateral radiographs. Fracture occurred in 1 specimen in the PSR group and in 4 anterolateral plate (ALP) specimens. The 5 specimens were harvested from 2

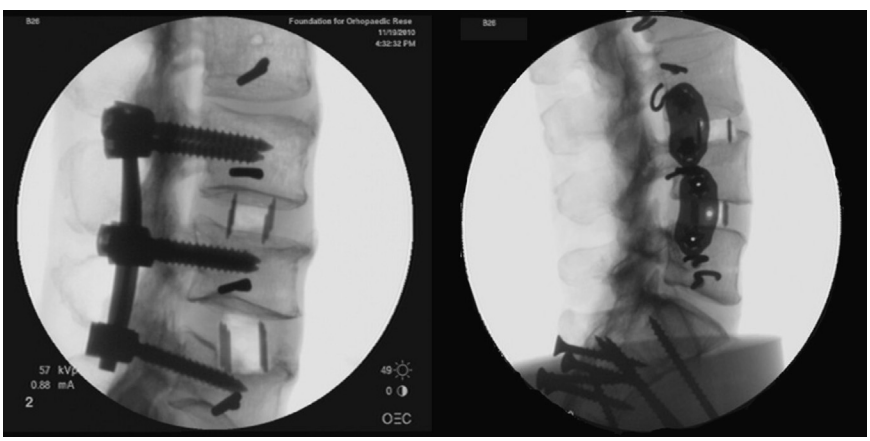

Fig. 1. Radiographic representative images of 2 endplate fractures sustained during lateral interbody cage implantation.