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Clinical Study

Incidence of graft extrusion following minimally invasive transforaminal lumbar interbody fusion

Joshua Bakhsheshian [a], Ryan Khanna [b], Winward Choy [b], Cort D. Lawton [b], Alex T. Nixon [b], Albert P. Wong [b], Tyler R. Koski [b], John C. Liu [a], John K. Song [c], Nader S. Dahdaleh [b], Zachary A. Smith [b], Richard G. Fessler [d,*]

[a] Department of Neurological Surgery, University of Southern California Keck School of Medicine, Los Angeles, CA, USA
[b] Department of Neurological Surgery, Northwestern Feinberg School of Medicine, Chicago, IL, USA
[c] Section of Neurological Surgery, Advocate Illinois Masonic, Chicago, IL, USA
[d] Department of Neurosurgery, Rush University Medical Center, 1725 W. Harrison Street, Suite 855, Chicago, IL 60612, USA

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ABSTRACT

Minimally invasive transforaminal lumbar interbody fusion (MI-TLIF) has been scrutinized for having a complex learning curve. Careful assessment of MI-TLIF complications and critical analyses of prevention may aid a safe adoption of this technique. The current report focuses on the incidence of interbody cage extrusions following MI-TLIF in a series of 513 patients. The authors discuss their experience with graft extrusions and provide methods to minimize this complication. This study retrospectively reviewed 513 prospectively followed patients who underwent MI-TLIF over a 10 year period. The inclusion criteria consisted of all patients who underwent one to three level MI-TLIF, from whom the incidence of cage extrusion was analyzed. Cage extrusion was defined as an interbody graft migrating outside the cephalad and caudal vertebral body posterior margin. Cage extrusions were diagnosed by comparing the intraoperative radiographs to the postoperative radiographs. Patients with >10° coronal curves, significant sagittal malalignment, infection, and preoperative instrumentation failure were excluded. Of 513 patients undergoing MI-TLIF, five patients (0.97%) were diagnosed with cage migrations. The mean follow-up duration was 13.6 ± standard deviation of 8.8 months. Complications included asymptomatic cage migration alone (two patients) neurological decline (two patients) and epidural hematoma (one patient). On average, cage migrations cost a university hospital an additional $US17,217 for revision treatment. While the incidence of cage migrations is low (0.97%), it can lead to postoperative complications that require revision surgery and increased hospital costs. The risk for this significant complication can be minimized with proper technique and patient selection.

1. Introduction

Transforaminal lumbar interbody fusion (TLIF) can be used to treat lumbar degenerative disease and spondylolisthesis. With a TLIF, decompression and cage placement can be performed through a unilateral approach. The transforaminal trajectory allows exposure of the disc space while minimizing retraction of the dural sac and nerve roots. The minimally invasive transforaminal lumbar interbody fusion (MI-TLIF) is performed through muscle-splitting tubular dilators and offers the potential advantage of reduced iatrogenic trauma to paraspinal muscles, less perioperative blood loss, quicker recovery and reduced risk of infection at surgical sites [1]. MI-TLIF is increasingly being utilized and it is important to have a firm understanding of minimizing potential complications.

Intervertebral graft sizing and placement with minimally invasive approaches can be technically challenging. The MI-TLIF approach has a complex learning curve, resulting in complication rates that vary with surgeon experience [1–3]. The use of narrow surgical corridors, limited anatomic references and reliance on fluoroscopic techniques adds to the challenge of accurate sizing and placement of interbody grafts. Additionally, compression and distraction using minimally invasive techniques can pose as further

* Corresponding author. Tel.: +1 312 942 6644; fax: +1 312 942 2176.
E-mail address: rfessler@rush.edu (R.G. Fessler).

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challenges. For these reasons, graft extrusion can occur with MI-TLIF if careful attention is not paid to endplate preparation, sizing of the interbody graft, and placement of screw and rod constructs.

Displacement of interbody grafts can cause serious clinical consequences. Posterior graft migration can cause compression of nerve roots, causing neurological decline and failure of fusion. Cage migration can both result in pseudoarthrosis as well as be a consequence of non-union. The average cost of revision surgery for cage migration reported is approximately $US14,785 per encounter [4]. Interbody graft migration after MI-TLIF has been reported to occur at a rate of 0.35–6% [4–6]. We evaluated the frequency of interbody graft migration occurring during MI-TLIF in a cohort of 513 patients, to identify predictors of cage extrusion and articulate technical nuances for surgeons using this approach.

2. Methods

2.1. Clinical data

After approval from the Institutional Review Board was obtained, a retrospective review was conducted for the incidence of graft migration. Cage extrusion was defined as an interbody graft migrating outside the cephalad and caudal vertebral body posterior margin. The review included prospectively collected data on 513 consecutive patients treated over a 10 year period. In contrast to the general complications previously reported in this patient cohort [7,8], this study focused on graft extrusions. Patients were selected using Current Procedural Terminology codes for MI-TLIF over a 10 year period. All patients undergoing one to three level MI-TLIF procedure for lumbar degenerative disc disease were included in the study. Patients with >10° coronal curves, significant sagittal malalignment, infection, and preoperative hardware failure were excluded. Demographic data collected included age, sex, and preoperative diagnosis. Operative data collected included level(s) of operation, operative time, estimated blood loss, and complications. Health-related quality of life variables were examined preoperatively and at 2 year postoperative follow-up.

2.2. Surgical procedure

The MI-TLIF technique was performed as previously described [9]. A 2.5 cm incision was made 4 cm lateral to midline and sequential muscle-splitting tubular dilators (METRx; Medtronic Sofamor Danek, Memphis, TN, USA) were then passed over one another until the working channel of 24 mm was obtained. After the disc is exposed, a discectomy is performed while checking the depth with fluoroscopic images. The end plate is prepared with a disc scraper and curettes. An interbody spacer is used to determine the appropriate size of the cage. Cage types included polyetheretherketone (PEEK), carbon fiber reinforced polymer (CFRP), metal, allograft and tangent. The cage and interbody space was filled with a combination of autologous bone and recombinant human bone morphogenetic protein 2 (rhBMP-2) collagen sponge in the majority of cases. The rhBMP-2 impregnated collagen sponge volumes were 8 cm^3 and contained 12 mg of protein. Instrumentation with pedicle screws was performed through bilaterally as previously described [9]. Unilateral pedicle screw fixation was performed in a minority of cases at the surgeon's preference.

2.3. Radiological assessment

Cage extrusions were diagnosed as mentioned above by comparing the intraoperative radiographs to the postoperative radiographs. Lumbar radiographs were obtained at all follow-up points (2 weeks, 6 weeks, 3 months, 6 months, 1 year, continued annually). In cases where graft migration was a concern, a CT scan of the lumbar spine was obtained.

2.4. Data analysis

We determined the types of fusion cages used for TLIF and identified which types migrated most frequently. The incidence of cage migration was then compared between patients treated with unilateral and bilateral pedicle screw fixation and BMP use. For patients who experienced a cage extrusion, the hospital's billing and payment system was utilized to analyze the costs incurred from revision surgeries and inpatient stay.

3. Results

3.1. Surgical data

Five hundred thirteen patients were treated with MI-TLIF performed by four neurosurgeons over a 10 year period at two institutions. Mean follow-up for all patients was 13.7 ± standard deviation (SD) of 8.8 months. BMP was used in 480 patients (93.6%). A total of 432 patients underwent single-level TLIF, while 78 patients underwent two-level TLIF, and three patients underwent three-level TLIF, resulting in 597 total levels. The percentage of intervertebral graft types included 86.4% PEEK (n = 443), 10.3% CFRP (n = 53), 1.5% metal (n = 8), 1% tangent (n = 5) and 0.75% allograft (n = 4). The majority of patients underwent bilateral pedicle screw fixation (98.9%) while the others were unilateral (1.1%).

3.2. Graft migration data

There were five extrusions out of 597 levels operated (0.84%) and five out of the 513 patients (0.97%) had cage migrations diagnosed by comparing the intraoperative radiographs to the postoperative radiographs (Table 1). Preoperative diagnoses included spondylosis, spondylolisthesis, spondylolysis, and degenerative disc disease. There were two males and three females with an average age of 62 ± SD 19 years (range 38–82 years). The timing of graft extrusions being diagnosed ranged from postoperative day 2–40.

Table 1
Demographics, operating room time, estimated blood loss, spinal level, timing to complication and etiology of the five patients with cage migration following minimally invasive transforaminal lumbar interbody fusion

Patient	Age, years	Sex	Levels	OR time, minutes	EBL, cc	BMP	Cage type	Time to extrusion	Revision	Etiology
1	82	F	L4–S1	270	125	Y	PEEK	POD 3	Y	Posterior graft subsidence/repositioning, hematoma
2	74	M	L4–L5	210	150	Y	PEEK	POD 19	N	Posterior migration
3	47	F	L4–S1	319	500	Y	PEEK	POD 40	N	Posterior migration
4	70	F	L4–L5	137	400	N	CFRP	POD 2	Y	Fragment of graft in canal
5	38	M	L5–S1	288	50	Y	PEEK	POD 4	Y	Cage slip

BMP = bone morphogenetic protein, CFRP = carbon fiber reinforced plastic, EBL = estimated blood loss, F = female, M = male, N = no, OR = operating room, PEEK = polyetheretherketone, POD = postoperative day, Y = yes.