Case Series of Anterior Intervertebral Graft Extrusions in Transforaminal Lumbar Interbody Fusion Surgeries

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BACKGROUND: According to the published reports, revision surgery is sometimes recommended even in patients with asymptomatic anterior lumbar intervertebral graft migrations. The main purpose of this chart review study was to report on the clinical course and outcomes of patients who had anterior intervertebral graft extrusions after transforaminal lumbar interbody fusion (TLIF).

METHODS: From July 2002 to July 2014, 1259 consecutive TLIF surgeries were performed. These were reviewed, and patients who had anterior intervertebral graft extrusions were identified.

RESULTS: The incidence of graft extrusion was 0.6% (7 of 1259 patients). There were 6 female patients and 1 male patient with an average age of 65.7 years (range, 44–80 years). All patients underwent TLIF with bilateral pedicle screw fixation, and 6 received recombinant human bone morphogenetic protein-2. Graft migrations were diagnosed between 5 days and 8 months postoperatively except for 2 cases in which migration occurred intraoperatively. The patients were closely followed for an average of 27.4 months (range, 12–43 months). All patients remained asymptomatic during the follow-up period and had solid fusion despite extrusions with an average time to fusion of 13 months (range, 10–18 months). No other adverse events occurred during the follow-up period.

CONCLUSIONS: The risks of additional and highly invasive revision surgery should be weighed against the potential short-term and long-term complications associated with graft extrusions or migrations. It was demonstrated that fusion may take longer but can be achieved, and close observation may be adequate for asymptomatic patients.

INTRODUCTION

Lumbar intervertebral graft extrusion is a complication that can occur during or after lumbar interbody fusion procedures. The clinical implications of graft extrusion depend on the location. Posterior implant migrations into the spinal canal can cause nerve root compression symptoms and usually require revision surgery.¹⁻⁶ Kuslich et al.⁷ reported 1.7% of posterior implant migrations requiring reoperation and 1.4% without reoperation. The reported rate for posterior graft migration is 0.8%–3.2%.¹⁻⁴,⁶⁻⁹ Only 1 posterior lumbar implant migration case out of 11,817 spinal operations accounted for major neurologic deficit (paraparesis) that resulted in spinal canal compromise.¹₀

Anterior graft extrusions are less frequent but may occur more easily if the structural integrity of the anterior anulus fibrosus or the anterior longitudinal ligaments is inadvertently compromised. A few published case reports described complications and management strategies associated with retroperitoneal graft migrations. Retroperitoneal migrations may lead to vascular complications,¹¹⁻¹³ damage to the viscera,¹⁴ or radicular symptoms.¹⁵ Revisions for asymptomatic cage migrations³,¹⁶ and pseudarthrosis¹⁷ were also described in the literature. The reported rate for anterior graft migrations is 0.8% with reoperation and 1.5% without reoperation.⁷ According to the published reports, revision surgery is sometimes recommended in cases of anterior lumbar intervertebral graft extrusions.³,¹⁶

The main purpose of this retrospective chart review study was to report on the clinical course and outcomes of patients who had...
anterior intervertebral graft extrusions after transforaminal lumbar interbody fusion (TLIF).

MATERIALS AND METHODS

Among 1259 consecutive TLIF surgeries performed by 3 surgeons from July 2002 to July 2014, we prospectively identified patients who had anterior intervertebral graft extrusions and reviewed their medical records and imaging studies. Data collected included sex, age, body mass index, preoperative diagnosis, previous lumbar surgeries, comorbidities, smoking status, detailed notes on surgical procedures, and complications. All patients underwent open TLIF procedures with attempted bilateral pedicle screw placement using three-dimensional image guidance. The surgical technique was described previously.18

Follow-up appointments occurred at approximately 7–14 days postoperatively, at 3 and 6 months, and annually thereafter. Intervertebral graft extrusions were diagnosed if an implant moved at least 2 mm past the line connecting the anterior margins of the rostral and caudal vertebral bodies, and the distance from that line was measured. Radiographic fusion was determined to be present if there was a <5° difference in angular motion between flexion and extension on plain radiographs or no radiolucency lines >2 mm in thickness covering >50% of the superior or inferior surface of the grafts.

RESULTS

Out of 1259 cases, 7 patients (0.6%) were identified as having anterior intervertebral graft extrusions. There were 6 female patients and 1 male patient with a mean age of 65.7 years (range, 44–80 years). All patients were undergoing surgery for painful degenerative disk disease with radiculopathy (n = 1), spondylolisthesis (n = 3), or spinal stenosis (n = 4) symptoms. The average body mass index was 25.2 (range, 20.1–30.7). Osteopenia was present in 2 patients; there were no other comorbidities that could affect fusion. Two patients were smokers. In 5 patients, a 1-level TLIF procedure was performed; 2-level surgeries were performed in 2 patients. All patients underwent TLIF with bilateral pedicle screw fixation, and 6 patients received recombinant human bone morphogenetic protein-2 (rhBMP-2). Polyetheretherketone (PEEK) spacers were used in 5 patients, cortical bone allografts were implanted in 2 patients. Banana-shaped cages 7–10 mm in size were used in all patients. Patient characteristics are listed in Table 1. Of 7 patients, 3 (42.9%) had scoliosis with curvature of 15°–22°, and 3 patients (42.9%) were undergoing surgery for spondylolisthesis. A statistically significant (P = 0.013) reduction of spondylolisthesis was achieved from an average of 7.2 mm (range, 6.0–8.8 mm) to 4.7 mm (range, 2.0–3.0 mm).

Radiographic evidence of graft extrusions was observed during regular follow-up visits between 5 days and 8 months postoperatively except for 2 grafts in which extrusion occurred intraoperatively. One of these grafts completely migrated into the pelvic cavity anterior to the sacrum, and another graft migrated ventrally into the prevertebral space at the L5/S1 level. The remaining graft extrusions measured 8–20 mm. No disk space loss (average preoperative disk height was 5.6 mm [range, 3.9–7.3 mm], and average postoperative disk height was 8.2 mm [range, 6.3–11.7 mm]) or segmental kyphosis was noted.

| Patient | Age (years)/Sex | Preoperative Diagnosis | Level | BMP | Graft | Follow-Up | Fusion (months) | Extrusion level | Extrusion (mm) | Symptoms | Revision Surgery |
|---------|----------------|------------------------|-------|-----|-------|-----------|---------------|----------------|---------------|-----------|----------------|----------------|---|
| 1       | 80/F           | Spinal stenosis/       | L3-L5 | L4 | PEK   | 27        | 12            | 0.2            | 14            | NA        | No             |                |   |
| 2       | 78/F           | Radiculopathy          | L4/L5 | L4 | PEK   | 12        | 10            | 6              | 14            | NA        | No             |                |   |
| 3       | 71/F           | Spinal Stenosis/scoliosis | L4/L5 | L4 | PEK   | 43        | 18            | 8              | 20            | NA        | No             |                |   |
| 4       | 71/F           | Spinal stenosis/scoliosis | L4/L5 | L4 | PEK   | 24        | 13            | 10             | 8             | NA        | No             |                |   |
| 5       | 58/F           | Spinal stenosis        | L2/L3 | L2 | Allograft | 34       | 3             | 12             | 3             | NA        | No             |                |   |
| 6       | 44/F           | Spondylolisthesis      | L4/S1 | L4 | PEK   | 40        | —             | —              | —             | NA        | No             |                |   |
| 7       | 57/M           | Spondylolisthesis      | L5/S1 | L5 | S1    | 15         | L5/S1         | 12             | —             | —         | No             |                |   |

TLIF, transforaminal lumbar interbody fusion; BMP, bone morphogenetic protein; Extr., extrusion; F, female; M, male; MCD, microdiskectomy; PEEK, polyetheretherketone; NA, not applicable.
The average follow-up time was 27.4 months (range, 12–43 months), and the patients’ clinical status was closely monitored during that time. All patients remained asymptomatic and all extrusions remained stable during the follow-up period. A soft lumbar corset was prescribed for 6 weeks, but the patients were encouraged to become active as soon as possible after surgery with limited lifting and bending or twisting of the lumbar spine. After this 6-week period, standard physical therapy was recommended with limited range of motion, flexion, extension, and lateral bending until fusion had been documented. All patients had solid fusion despite extrusions. For the patients who had intervertebral space graft extrusions, the average time of fusion was 13 months (range, 10–18 months).

Case Study

A 44-year-old woman presented with axial low back pain and bilateral radiculopathy resulting from foraminal stenosis and spondylolisthesis at L4/L5 and L5/S1 levels with spinal instability. She previously underwent multiple laminectomies at L4/L5 and L5/S1 at an outside institution and developed a postlaminectomy syndrome, which was also complicated by postoperative pseudomeningocele and required operative repair. Two-level posterior decompressions and TLIFs with bilateral pedicle screw fixation were performed. The pedicle screws were placed at L5 on the right and bilaterally at S1 and L4. The left L5 pedicle was dysplastic and would not accept the screw. The rods were inserted, and some reduction of spondylolisthesis was achieved. Diskectomies were performed at L4/L5 and L5/S1. After complete removal of disk material and placement of a PEEK cage into the L5/S1 space, the cage felt slightly loose, and it subsequently slipped into the pelvic cavity and anterior to the sacrum. The additional portions of the ventral aspects of the disk were removed, but the implant could not be removed, and it was decided to leave it in place. Another intervertebral PEEK graft was selected and inserted into the L5/S1 disk space. Postoperatively, there were no clinical signs of either arterial or venous vascular occlusion. A vascular surgeon was consulted, and it was decided that there was no need for computed tomography (CT) angiography or surgical intervention to retrieve this graft because it was highly unlikely that it would cause any vascular injury.

The patient experienced significant improvement of her symptoms after surgery. She was closely followed for 40 months, and the extruded implant remained proximal to the sacral prominence with no signs of migration (Figure 1).

DISCUSSION

In addition to shortcomings in surgical technique that include perforation of the anulus fibrosus and anterior longitudinal ligament, disk space violation, inadequate fixation, improper endplate preparation or graft placement, and multiple other risk factors responsible for graft migration have been explored. Graft migration can also occur in the settings of osteomyelitis, diskitis, or pseudarthrosis.4,19 Zhao et al.6 retrospectively analyzed posterior graft migrations in 6 of 512 TLIF surgery cases and found that the size and shape of the graft, number of fused segments, and adjacent segment endplate shape may be contributing factors. McAfee et al.3 questioned the posterior approach per se as not being able to achieve sufficient distraction of the disk space and as a result placement of cages that are too small. Kimura et al.9 described “pear-shaped disks,” which are widely open anteriorly as they have a concave surface in the anterior portion and a convex surface in the posterior portion of the superior and

Figure 1. Postoperative plain x-rays (lateral view) demonstrate graft extrusion into the pelvic cavity (A) and stable position of the graft 3 years later (B).
inferior endplates. Of 9 retropulsions after posterior lumbar interbody fusion, 8 were reported in patients with pear-shaped disks, especially if the L5/S1 level was involved. The authors also suggested that cages with 3°–5° lordosis do not fit the pear-shaped disks because they lack stability in the posterior aspect and sagittal plane of the disk space. Similar conclusions in regard to the shape and size of the implants were reached by Aoki et al., but they also noted that higher posterior disc height and unilateral pedicle screw fixation, especially if scoliosis was present, could facilitate posterior graft migrations. Although we did not specifically evaluate the risk factors in this study, 3 (42.9%) of 7 patients in our study had spine scoliotic curvature of 15°–22°, and we believe this contributed to some degree to the spinal misalignment and resulted in the reduced interface and stability between the implant and bone surface.

Pedicle screw and rod fixation provides immediate stability before the healing process occurs and an implant is secured in the disk space. Although bilateral pedicle fixation was attempted in all patients in our series, 1 patient had unilateral pedicle fixation at the level of the extruded graft because the pedicle was not solid enough after repositioning, and an additional pedicle screw was placed at the adjacent level. During screw placement, 2 patients had slight fractures in the pedicles, and fixation was reinforced with interspinous process fixation devices. Another patient had a poor bone-screw interface, which was reinforced with cement. As a result, 4 of 5 patients with postoperatively extruded grafts had suboptimal pedicle screw placement and fixation in cases in which graft extrusions occurred postoperatively. There was an anterior annular tear in both of the intraoperative graft extrusion cases. We believe that shortcomings in surgical technique were the leading cause for all these anterior graft extrusions.

The shape and type of the cage and positioning also could affect cage migration. The titanium cages migrated ventrally within the disk space more easily than PEEK grafts: The change in position of the interbody devices was 15.8% ± 7.8% for titanium cages versus 8.2% ± 7.1% for PEEK grafts. The authors did not report any graft extrusions, but they concluded that if migration is too pronounced, it may lead to a loss of the restored disc height. Similar findings were reported by Smith et al. in a prospective cohort study that compared carbon fiber implants with biodegradable implants made from poly-L-lactide-co-D,L-lactide in patients undergoing instrumented TLIF procedures. Of 44 patients, 8 (18.2%) had biodegradable cage posterior migrations, and 3 patients had pseudarthrosis as a result.

Osteolysis caused by the use of rhBMP-2 was also identified in several reports as a contributing factor responsible for graft migration. Vaidya et al. thought that because of transient osteolysis and endplate resorption as a normal part of the bone remodeling process at the site of rhBMP-2 implantation, the postoperative period from immediately postoperatively to 3 months carries a higher risk for implant loosening, migration, and subsidence. They did not observe any migrations beyond 6 months after new bone formation occurred, but the reported 35% posterior implant migration rate as a result of significant osteolysis is quite high.

In our series, rhBMP-2 was used in all but 1 patient, and most of the patients had graft extrusion diagnosed by the 3-month follow-up. In 1 patient, graft extrusion was identified at 8 months postoperatively, and it took 18 months for the patient to achieve fusion. Although there are contradicting previous reports on whether osteolysis or graft subsidence affects fusion, we observed that it took significantly longer (13 months on average) to achieve fusion in the patients who had a graft extruded in the intervertebral space compared with the results of our previously published study, where an average time of 4.1 months (range, 2–10 months) was reported, and all patients achieved radiographic fusion by 10 months.

In the case of retroperitoneal graft migration, some authors suggest that CT angiography and consultation with a vascular surgeon should be considered to determine the relationship of the migrated implant and the major vascular structures. In the cases reported here, a vascular surgeon was consulted, but it was decided not to perform CT angiography. These migrations occurred at the L5/S1 level, which lies below the bifurcation of the vascular structures, and the grafts were thought not to be in the direct proximity to major vessels. It can be justified that the decisions not to perform CT angiography are being made individually on a case-by-case basis. However, after reviewing the literature, we would recommend performing CT angiography to determine the exact location of the extruded graft given the potential devastating consequence of such complications. Yoshimoto et al. reported a case of deep venous thrombosis after posterior lumbar interbody fusion that was caused by a migrated bone graft fragment from the interbody site at L5/S1, which occluded the left common iliac vein at the bifurcation. The patient became symptomatic on the second postoperative day and underwent revision surgery and excision of the bone fragment. Another devastating complication was reported by Cakmak et al. In this case, the patient had a history of multiple fusion procedures from L3 through S1 complicated by surgical infection followed by a correction at L5 and revisions of interbody fusion through an anterior approach. A femur bone graft from the interbody fusion site migrated to the colon perforating the medial aspect of the cecum. Pawar et al. suggested a “lasso technique”: A No. 1 polyglactin 910 (Vicryl) suture is looped through the holes in the implant and removed when an optimal implant placement is achieved. The authors reported an inadvertent laceration of the inferior vena cava and migration of a titanium cage into the pulmonary artery. An attempt to use an oversized implant in a patient with spondylodiskitis and severe stretch of the anterior vascular structures may have contributed to this complication. Although a retroperitoneal approach was required to stop the bleeding, it was decided to leave the implant in place and monitor the patient closely because of the high morbidity of such a procedure.

Several authors performed revision surgeries because of asymptomatic anterior cage migrations. McAfee et al. reported a patient who underwent laparoscopic lumbar fusion using Bagby and Kuslich cages. Although the patient was asymptomatic, a CT scan performed at the 6-week follow-up evaluation revealed a dislodged cage anterior to the L5-S1 disk space. Revision surgery was also performed laparoscopically, and fusion was achieved at 24 months.

Proubasta et al. reported intraoperative retroperitoneal titanium-threaded cage migration during a posterior lumbar interbody fusion procedure at L5/S1. The posterior approach was abandoned at this stage, and the next day, after a CT scan confirmed the position of the cage near the great vessels,
patient underwent laparotomy to extract the migrated implant followed by posterolateral fusion with instrumentation.

Revision surgeries are more complex and associated with a higher risk of complications. In a series of 14 patients, 8 of whom had pseudarthrosis or infection with cage migration, 57% of patients had vascular complications, and 1 patient died while undergoing revision surgeries using either transperitonal or retroperitoneal approaches.\(^7\) The patients who initially underwent anterior lumbar interbody fusion had even higher rates of vascular complications. The average blood loss was 1400 mL (range, 150–5700 mL), the average operative time was 270 minutes (range, 119–420 minutes), and the average hospital stay was 9 days (range, 4–43 days). Fantini et al.\(^9\) retrospectively reviewed and reported on the incidence of major vascular injury during anterior lumbar spinal surgery. There was 1 case among 345 operations in which anterior migration of a posteriorly placed interbody implant was identified. The implant breached the anterior longitudinal ligament and adhered to the posterior aspect of the common iliac vein. Anterior revision surgery was performed with an estimated blood loss of 5000 mL.

**CONCLUSIONS**

The risks of additional and highly invasive revision surgery should be weighed against the potential short-term and long-term complications associated with graft extrusions or migrations. Although fusion may take longer, this can be achieved, and close observation may be adequate for asymptomatic patients.

**REFERENCES**


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