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Posterior Revision of Lumbar Interbody Fusion Cages Migration: Clinical Case Series and Literature Review

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Abstract

Background Data: Revision surgery for lumbar interbody cage migration is technically demanding.Cage related complication may lead to failure of fusion. Revision of such morbidity is associated with increased risk of permanent neurological insult.

Purpose: To analyze the efficacy of posterior approach and iliac crest auto grafting technique in revision of migrated intervertebral cages.

Study Design: Retrospective descriptive clinical case study.

Patients and Methods: From January 2010 to January 2016, we operated 106 patients underwent posterior lumbar interbody fusion (PLIF) with single cage application per level for treatment of degenerative spondylolisthesis. Of these, 12 patients experiencing cage subsidence and retropulsion. In subsidence, it was graded from 0 to III. Retropulsion was considered if the cage beyond the level of the posterior longitudinal line of the index two vertebrae. Patients were assessed pre-operatively for pain and clinical functional outcome by visual analogue scale (VAS) and Oswestry disability index (ODI), respectively. Patient with VAS score ≥5; at least 20% deterioration on ODI or with the superadded neurological deficit was considered candidates for revision surgery.

Results: Cage migration incidence was 11.3%, with subsidence (6.7%), and retropulsion (4.6%) of all patients. The average time for subsidence was 3.3 months (range 2 to 6 months). Five patients with grade-II and III subsidence underwent revision surgery for foraminal decompression, augmenting fixation and adding postero-lateral iliac crest bone graft. Retropulsion was encountered in 4 patients and all needed revision surgery for cage retrieval and redo fusion. Grade-I subsidence could be treated conservatively. All surgically treated patients had a good result in VAS and ODI after a second surgery which maintained during follow up with $P<0.05$.

Conclusion: Migration of posterior lumbar interbody fusion cage into the endplates or spinal canal is usually associated with patient dissatisfaction. Revision surgery indicated for cage retropulsion or high-grade subsidence. The posterior approach is technically demanding, safe, and effective for cage migration revision surgery. (2017ESJ141)

Keywords: Posterior lumbar interbody fusion, cage migration, posterior approaches, failed back surgery

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Introduction

Posterior lumbar interbody fusion (PLIF) is a standard surgical technique. Cloward in1940 was the first to describe PLIF.[28] In 1988, Bagby was the first surgeon who useda cage for disc reconstruction in horses.[30] In 1993 Brantigan and Steffee[6] published the first trial of spine fusion using cage. In the United States, more than 300,000 lumbar spine fusion are performed each year.[12]

Different cage designs (cylindrical, rectangular, banana, bullet) are available with different materials including; Polyetheretherketone (PEEK), carbon fiber reinforced PEEK, bioabsorbable polymers, or titanium).[11,20] Cages act as strut to support the axial loading, restore disc space height, restore foraminal height which is indirectly decompress nerve root. Cage has surface ridges to give primary stability against migration. Cages have slots inside to be filled at index surgery with bone graft tohelp fusion, boneingrowthadd for cage stability.[28,20]

Cage related complication like subsidence of the PEEK cage inside the vertebral body may leads to failure of fusion and reduction of the intervertebral foraminal height.[20,32] Retropulsion of the cage is more serious complication. It may lead to neural structures compression causing severe pain, motor weakness, cauda equine syndromeand permanent neurological damage. It is less frequent than subsidence and accounts for less than 1% of patients.[17,23]

Revision surgery for cage migration is associated with increased risk of permanent neurological damage due to excessive scar tissue dissection and tethered root manipulation[13] Technical consideration for cage removal have been little discussed in the literature.[33]Transdural,[33] anterior,[21] and or posterior approaches for cage removal have been used with considerable complications.[23,17]

This study aims to analyze safety and efficacy of posterior cage revision surgery and illustrating some technical tips to treat posterior lumbar interbody cage related complication.

Patients and Methods

Patient Population:

From January 2010 to January 2016, 106 patients with degenerative spondylolisthesis underwent PLIF for their disabling back pain and leg pain after failure of 6 months of conservative treatment. Each patient had at least one or two segment fixation with clinical and radiological follow up for at least 12 months to assess fusion. All levels had single posterior lumbar interbody PEEK cage (Egy fix®, Mubarak Industrial Area, Menofia, Egypt). The intervertebral cage height ranged from 9 to 13 mm. Cages were filled with locally harvested autogenous bone graft at the initial index surgery.

Postoperatively and during the follow-up, 12 patients complained of construct related complication as (cage subsidence, retropulsion or impending retropulsion). Revision surgery was scheduled if the patient developed a serious neurological insult, construct malpositioning and or significant complaint related to the failed construct with failure of conservative treatment.

Clinical Assessment:

Patients had pre-operative and postoperative-assessment by visual analogue scale (VAS) and Oswestry disability index (ODI), respectively. Postoperatively, patients were assessed clinically at: 1, 3, 6, 12 months, and every year thereafter.

Conservative treatment was considered unless the patient had VAS score ≥5; at least 20% deterioration on ODI.[5]

Radiological Assessment:

Plain X rays used to assess construct integrity and it was done at: 1, 3, 6, 9, 12 months postoperatively. On lateral plain X-ray film, subsidence was considered if the cage went through the lower endplate as follow: rgade-0, 0–24%; grade-I, 25–49%, grade-II, 50–74%, and grade-III, 75–100% collapse of the index level. Grades-0 and I were considered low-grade while Grades-II and III were considered high-grade subsidence.[18]

Retropulsion was considered if the cage was beyond the level of the posterior longitudinal line of the index two vertebrae.[23,17]

Throughout the follow-up, CT scan was taken on demand or after one year to verify implant position and bony fusion. Fusion was considered if bridging bone appeared between the two adjacent vertebras, or through and around the cage, together with absence of radiolucent line around the cage more.[18] Magnetic Resonance Imaging used to assess the neural element compression, adjacent disc pathology and any suspected soft tissue pathology.

Operative Notes:

Under general anesthesia, patient positioned prone with free abdomen to decrease intraoperative epidural venous bleeding. Laminectomy was done then deep soft tissue dissection and neurolysis was done. Dissection started from healthy to scared tissue. Laminectomy and/or medial facetectomy was done till we reach a safe corridor to the pathological disc and cage. Intraoperative imaging and microscope for localization and dissection of migrated implant is recommended. The screw caps and the titanium rods were removed. Screws were examined for loosening with replacement of loose one by longer, larger diameter screw. We packed the revised screw track by harvested cortico-cancellous local autograft and or iliac crest autograft. Construct augmentation by adding more screws were performed if needed.

Cages with impending retropulsion or retropulsion: the detailed operative technique was described in (Figure 1). During surgery, when the dura and nerve root became more mobile, we did a gradual guided distraction of the transpedicular screw. After successful cage removal, adequate cage size packed with iliac crest cancellous bone autograft was placed. Before the cage insertion, bone ships anterior to the cage were packed as a fusion enhancing procedure. (Figure 2) If the disc space was roomy, bear shaped or wider posteriorly than anteriorly a well impacted anteriorly located autologous cortico-cancellous local and or iliac crest bone graft was inserted instead of the cage followed by posterior applied segmental compression aiming for bony fusion. (Figure 3)

Cage subsidence that mandated surgery: foraminal decompression was done. Construct was re-stabilized by replacing any loose screw, and or adding more anchorage points. Fusion enhancement by iliac crests autologous bone graft application posterolateral over the Inter-transverse ligament.[4] (Figure 4)

Wound was closed in layers. The suction drain was inserted after proper hemostasis.

Statistical Analysis:

Statistical analysis was performed by Statistical Package for Social Science SPSS (version 20, Chicago, Inc.). Parametric data for each variable was presented in Mean±SD. Categorical numeric data were analyzed using chi-square test, with a level of significance of $P<0.05$.

Results

Hundred and six patients underwent PLIF for treatment of degenerative spondylolisthesis, 12 patientshad implant related complications either cage subsidence or retropulsion. The incidence of cage migration was 11.3%. There were 4 male and 8 females with an average age of 46±18.3 (Range 28 to 65) years. The average follows up was 19.6±10.4 months (Range, 9 to 34 months). (Table 1)

Subsidence was reported in 8 patients (7.5%). The average time for subsidence to occur was 3.3 months (Range 2 to 6 months). Six patients experienced cage subsidence at L4/5 and two at L5/S1. All patients presented with sudden onset back pain with or without radicular pain. Subsidence grades were described in table 1. Subsidence occurred in the lower end plate in 62.50% of patients, and 37.5% involved both sides. Three patients with grade-I subsidence treated conservatively, one of them associated with mild subclinical infection managed conservatively by brace and antibiotics with improvement of the patient symptoms at follow up. Five patients (62.5%) (Three grade-II subsidence and two grade-III subsidence) had a surgical intervention. These five patients underwent foraminal decompression and posterolateral auto graft fusion, plus construct revision in three of them.

Retropulsion was reported in four patients, 3 patients at L4/5 (2.8). The retropulsion was detected in 1.82 months (Range, 1-3 months). Migrated cage was retrieved in all patients; one patient had construct augmentation by adding anchorage points in adjacent level. Fusion was augmented by interbody iliac crest bone graft application in all 4 patients. In two patients larger cage insertion filled with iliac crest bone graft was applied.

The mean operative time was 190.6±30.2 min and mean blood loss was 740.4±102.4 ml. One patient had postoperative superficial infection managed by debridement and antibiotic. Another patient had CSF leakage managed conservatively, with mild nonspecific radicular pain from mild arachnoiditis.

The average postoperative hospital stay was 2.6±3.2 days. VAS and ODI after the second surgery and during one year follow up showed statistically significant improvement as shown in Table 2.

Table 1. Descriptive Data of Cage Migration Patients (N=12 of Total 106 Patients)

Total patients		**Cage Migration**	**%(N=12)**	**%(N=106)**
Age (Mean±SD/Years)		46±18.3		
Sex	Female Male	8 4	7.5% 3.3%	(66.7%) (33.3%)
Clinical features	Back pain Sciatica Neurological weakness	12 8 3	11.3% 7.5% 2.8%	(100%) (66.7%) (25%)
Average operative time		190.6±30.2 min		
Blood loss		740.4±102.4 ml		
Subsidence	Total Grade I Grade II Grade III	8 3 3 2	7.5% 2.89% 2.8% 1.9%	(66.7%) (25%) (25%) (16.7%)
Subsidence	Total L4/L5 L5/S1	8 6 2	7.5% 5.7% 1.9%	(66.7%) (50%) (16.7%)
Comorbidities	Total Hypertension Diabetes Cardiac comorbidities Smoking	4 3 2 1 3	3.7% 2.8% 1.9% 0.9% 2.8%	(33.3%) (25%) (16.7%) (8.3%) (25%)
Subsidence	Total Lower end plate Both end plate	8 5 3	7.5% 4.7% 2.8%	(100%) (62.5%) (37.5%)
Retropulsion	Total L4/5 L5/S1	4 3 1	3.7% 2.8% 0.9%	(100%) (66.7%) (33.3%)
Conservative (subsidence I) Surgical interventions Subsidence Retropulsion		3 9 5 4	2.8% 8.4% 4.7% 3.7%	(25%) (75%)
Mean follow (month)		19.6±10.4		

Table 2. Univariate Analysis of Clinical Outcome of Cage Migration: One Year Follow-up

Outcome Parameters	Mean±SD	P value
VAS Pre-operative	7.0±1.8	
VAS immediate postoperative	4.3±2.1	P<0.005
VAS one year after surgery	3.0±1.8	P<0.005
ODI Pre-operative	30.1±3.9	
ODI immediate postoperative	19.2±3.5	P<0.003
ODI one year after surgery	17.1±2.9	P<0.002

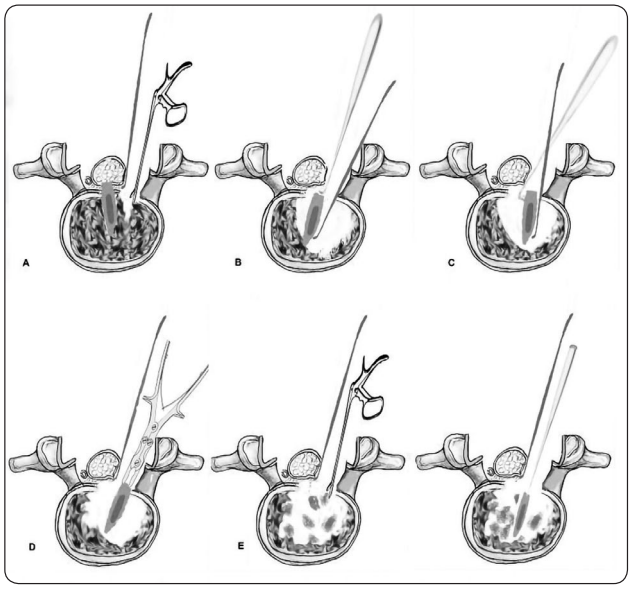

Figure 1. Cage retropulsion removal. (A) The fibrous tissue inside the affected disc is removed by disc shavers and straight rongeur, Penfield dissector used to retract the dura. (B) An angled curette was introduced underneath the dura and disc spaces, the cage lower anterior end is pushed with the dissector toward the contralateral side hence the cage posterior end moves into the disc opening. (C) The curette turned to the opposite side of the cage while the Penfield dissector still pushing on the lower end of the cage on the same side. (D) A safe blunt edge Kerrison rongeur used to remove the cage. (E) Autologous iliac crest bone graft and or cage were inserted aiming for bony fusion.

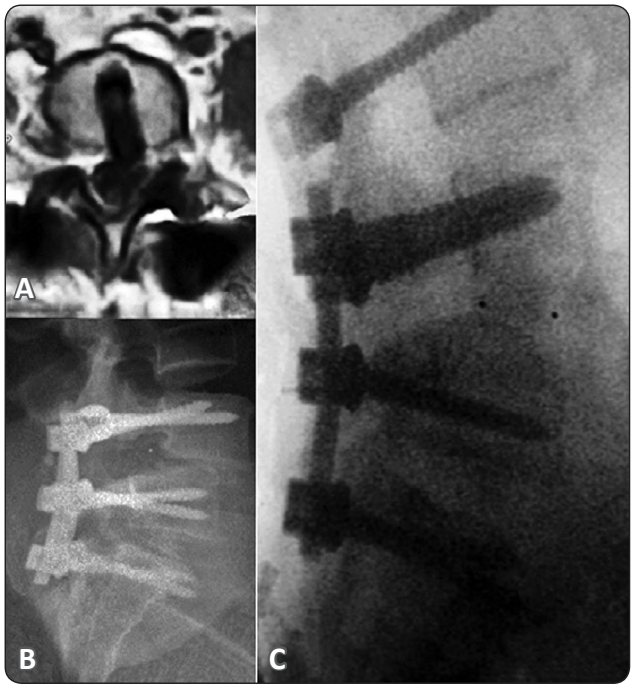

Figure 2. Cage retropulsion in 42 years old female. (A) MRI axial radiographs revealed large retropulsed cage. (B) Lateral X-ray film revealed loosening of the L4 screws and retropulsion of the cage, with sagittal imbalance. (C) Intraoperative L3/S1 lateral X-ray showed construct augmentation with more proximal anchorage point,cage reapplication inside L4/5 space with iliac crest bone graft aiming for bony fusion.

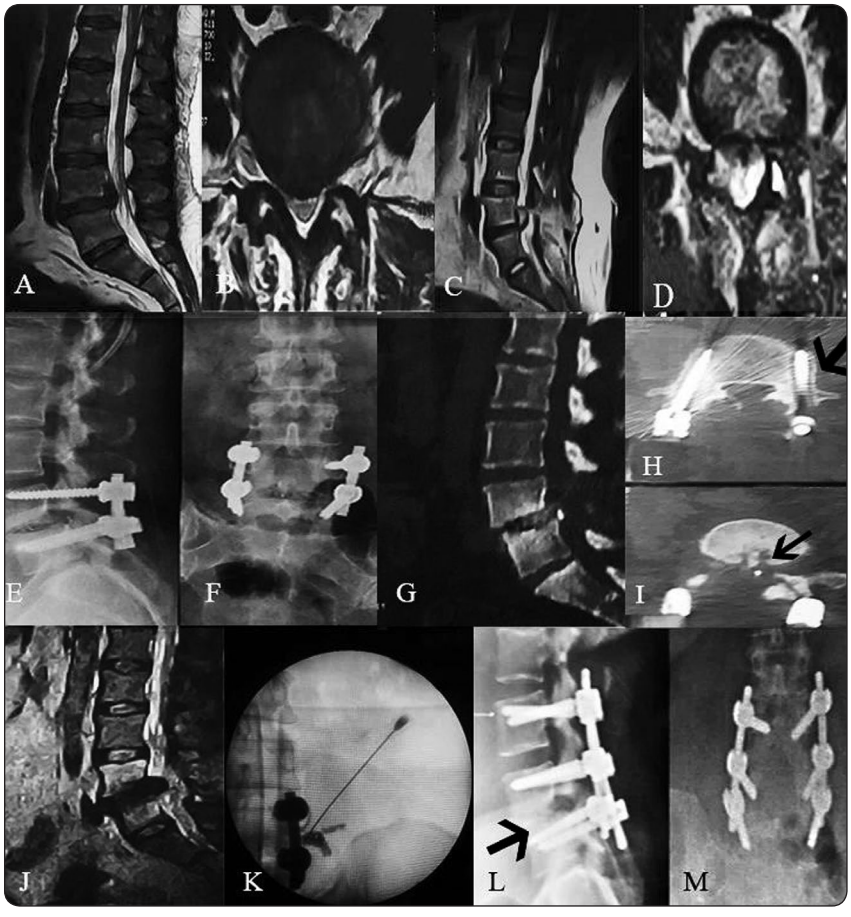

Figure 3. Cage retropulsion in 39 years old female. (A,B) Preoperative MRI T2 sagittal and axial radiographs revealed large disc and degenerative spondylolisthesis L4/L5. (C,D) Postoperative MRI T2 sagittal and axial radiographs revealed residual disc and fenestration laminotomy. (E,F) Lateral X-ray film revealed loosening of the L4 screws and retropulsion of the cage. (G,I) Lumbar CT sagittal cut and L4/L5 axial cuts showed cage retropulsion and loosening of L4 screw (black arrow) with the cage inside the canal (black arrow). J) MRI T2 sagittal and axial radiographs revealed large cage shadow inside the canal. K) Selective nerve root block. (L,M) Plain-X ray at six months later after construct augmentation by L3 screws and application of interbody bone graft only due to wide posterior disc space height (evident in CT sagittal cut), showed early bony fusion at L4/5 (black arrow).

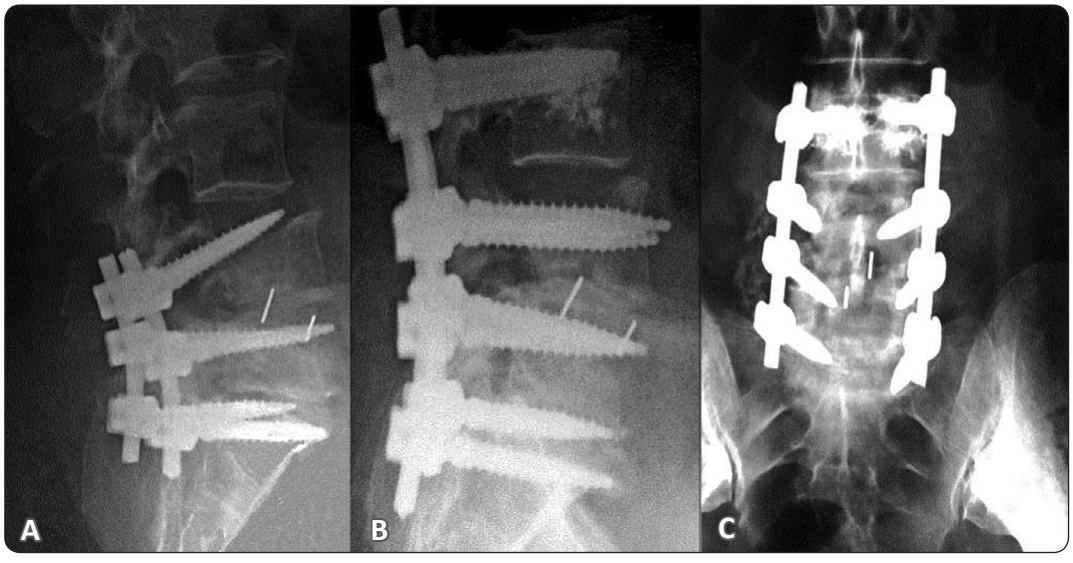

Figure 4. Interbody cage subsidence in 65 years old male. (A) lateral X-ray film revealed cage with grade II subsidence together with a loosening of the L4 screws. (B) L3/S1 lateral X-ray showed sagittal reconstruction with bi-cortical screw insertion at L4 and cement augmented screw at L3 screw. (C) Ant-Post X-ray show construct and the intertransverse posterolateral iliac crest bone graft.

Discussion

Posterior lumbar interbody fusion (PLIF) is a surgical treatment option in degenerative spondylolisthesis. Cage related complications like subsidence and migrationare not uncommon. Clinically symptomatic cage migration into the endplates or spinal canal is a devastating cause of failed back surgery.[1] When lumbar cage subsidence occurs there are many concerns about recurrence of foraminal stenosis and sagittal malalignement.[18] Cage retropulsion leads to compression of the neural structures with progressive back pain and sciatica.[23,33]

Cage Subsidence:

Cage subsidence is debatable issue, some surgeons consider it as an expected scenario,[16,18,20] while others consider it as a complication.[18] Such statement could be explained by the fact that low-grade subsidence may be completely asymptomatic and may enhance interbody bony fusion while high-grade subsidence are symptomatic and may require reoperation. Marchiet et al,[18] suggested that low-grade subsidence can stabilize by time with improved surgical outcome. Furthermore, they reported bony fusion in grade-III subsidence without revision surgery. In this study, we had five from eight patients required revision surgery with foraminal decompression and fusion enhancement by inter-transverse bone graft application.

Segmental lordosis is usually maintained by different cage designs[14] or by anterior application of the lumbar cage that distract more the anterior disc space.[8] Hence, anterior subsidence is usually associated with progressive spinal deformity, posterior one is much related to the risk of stenosis.[9,18] In this study, as with others, subsidence occurred in the first three months.[8,16] It is rarely that subsidence can occur after 6 months.[27]

Studies reported many risk factors for subsidence including osteoporosis, multilevel fusion, older age, female sex, and obesity.[15,18] Cage subsidence occurs more frequently at L5/S1 and less in L4/5.[9] L5/S1 and then L4/5 have a different disc angle compared with other levels. In addition, pedicle fixation at L5/S1 level showed less rigid screw construct.[17,23,33] However, in this study, we reported 6 patients at L4/5 and 2 at L5/S1 as most of patients was degenerative spondylolisthesis at L4/5.In this study, one patient had subsidence due to mild subclinical infection. We believe that subsidence in most of our patients are due to extensive endplate curettage and preparation .To prevent subsidence, it is recommended to avoid extensive rigorous end plate preparation that may expose weak subchondral bone at the cage bed.[24,18,27,10] Additionally, many studies[25,31] have found the lumbar cage subsidence was attributed to small cage with smaller footprints.

Retropulsion:

In a large study by Kimura et al,[17] included 1070 patients, they found that cage migration occurred in less than 1%. Many factors had been discussed for cage retropulsion; obesity, osteoporosis, old age were considered patient related factors for cage migration.[23,34] Due to the cage design, patient with higher posterior disc height as in this study had been suggested as a causative factor for cage migration and this was suggested in other case series.[2]

Construct loosening as in one of our case series, low-grade infection, local segmental kyphosis and failure to compress the posterior anchorage points after cage application at the index surgery all are possible causes of retropulsion. Rectangular PEEK cage, bullet shaped cage, closed box cage, small size cage, and technical faults considered as cage related factors for migration.[12,7,23,34] The PLIF technique itself was considered as a factor for retropulsion. In this study, we consider midline cage location may be responsible for cage migration.[1] Laminectomy and medial facetectomy for PLIF were considered a migration factors.[7,23] Multilevel fusion has increased risk for retropulsion.[2] Two cages insertion in one level can lead to migration of one cage due to instability created from unequal stresses in such level.[23]

Through our study we believe that bad cage design and midline cage insertion attribute to difficulties in posterior compression at index surgery. This helped the occurrence of retropulsion or impending retropulsion with focal segmental kyphosis.

In this study, the average postoperative hospital stay was 2.6±3.2 days, where it was reported 5.75±1.7 days in other study.[23] Patients in this study were allowed to move with bracing and to do mild exercise. Early mobility and exercise enhance local circulation, promote fusion, and may prevent cage migration.[10,17,19,23,27,33]

Surgery:

Few small cases series reported for cage migration.[3,8,10,17,33] However, revision surgery for cage subsidence and retropulsion is technically demanding. Many approaches had been used for removal of cages with their relative risk.[17,23,33,19] In this case series, posterior revision surgery was planned. We recommend the use of magnifying loop or microscope for better visualization in such surgeries.

In the posterior approach, neural mobilization and adhesolysis carrying a risk of leg pain or nerve palsy.[7] Aoki et al,[3] reported that cage removal in TLIF is less difficult than PLIF as the cage tends to be found more laterally. Bleeding, infection, the myofascial pain was reported from 15 to 30% of patients.[2,19] Due to its difficulties, transdural removal of the cage was suggested by Zaidi et al,[33] with good recovery.

In this study, we tried to illustrate the technical tips and method of safe retrieval and removal of the posteriorly migrated PLIF cage. The authors recommend that after cage insertion, posterior compression should be applied to prevent cage migration and stabilize the operated lumbar segment in better lordosis.

In the anterior approach, surgery is demanding with risk of approach-related complications. Glassman et al,[13] described a successful approach for removal of an anterior cage with no complication. However, they performed a partial vertebral resection. Nguyen et al,[21] reported a series of 13 patients with cage migration. They described the removal of cages through an anterior approach with 71% complication rate. They reported 57% vascular injury and one death from multiple venous injuries. Oh et al,[22] reported deterioration after anterior removal of the cage, and posterior approach was used for revision of pedicle screw insertion and root decompression. Other reported complication including; abdominal muscle weakness, paralytic ileus, and retrograde ejaculation.[23,13,21]

In lateral approach, although it carries access through a healthy non-operated corridor, it carries the possibility of injury to the lumbar plexus in the psoas muscle.[22] Neurophysiologic monitoring is essential to avoid such complication. Posteriorly located cages carry the risk of dural tear with cerebrospinal fluid CSF leak. It carries a risk of vascular injuries.[19] Comparable to other approaches, L5-S1 cage istechnically difficult for removal through lateral approach due to high riding iliac crest.[19]

Limitations:

The study had some limitation. Small number of patients, Retrospective nature of the study and no long term follow up for our patients.

Conclusion

Migration of posterior lumbar interbody fusion cage into the endplates or spinal canal is usually associated with patient dissatisfaction. Revision surgery indicated for cage retropulsion or high-grade subsidence. The posterior approach is technically demanding, safe, and effective for cage migration revision surgery.

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الملخص العربي

مراجعة الأقفاص القطنية المهاجرة ما بعد جراحة التحام الفقرات القطنية من الخلف: سلسلة من الحالات مع المراجعة العلمية

البيانات الخلفية: تعد جراحة مراجعة هجرة القفص القطني بين الفقرات القطنية صعبة من الناحية الفنية

الغرض: تهدف الدراسة إلى تحليل فعالية مراجعة الجراحة الخلفية للأقفاص القطنية المهاجرة.

تصميم الدراسة: دراسة وصفية بأثر رجعي.

المرضى و الطرق: من يناير 2010 إلى يناير 2016، خضع 106 مريضا لجراحة تثبيت والتحام الفقرات القطنية من الخلف لعلاج حالات التزحزح الفقاري. من هؤلاء، 12 مريضا كانوا يعانون من هبوط قفص داخل الفقرة أوالإزاحة الخلفية للقفص. وكان الهبوط متدرج من إلى مستوى الثالث. واعتبرت الإزاحة الخلفية إذا كان القفص خارج مستوى الخط الطولي الخلفي بين الفقرتين القطنيتين. تم تقييم المرضى قبل العملية لشدة الألم والنتيجة الوظيفية السريرية من خلال مقياس التماثلية البصرية ومؤشر العجز أوزويستری على التوالي. واختيرت الجراحة للمرضى الذين يعانون من مستوى الم ≤ 5 على مقياس الألم؛ وما لا يقل عن 40٪ تدهور على الوظيفة السريرية اوزويستری, أو مع العجز العصبي المتزايد.

النتائج: بلغت نسبة الإصابة الكلية للأقفاص إلى 11.3٪، و الهبوط إلى 6.7٪, وحالات الإزاحة إلى 4.6% . وكان متوسط وقت حدوث الهبوط 3.3 شهر (تتراوح من 2 إلى 6 أشهر). وقد خضعت خمس حالات لتخفيف الضغط على جذور الأعصاب مع زيادة تثبيتها من خلال الترقيع العظمي الخلفي باستخدام رقيقات عظمية من عظام الحوض. وكانت جميع الحالات الجراحية إما للمستوى الثاني أو الثالث لهبوط القفص. وقد تم حساب الإزاحة للقفص إلى 4 حالات، وكانت جميع الحالات بحاجة إلى المراجعة والاندماج. كان لجميع المرضى نتيجة جيدة بمقياس الألمأو مقياس أوزويستری بعد الجراحة الثانية وكانت النتائج الإحصائية ذات دلالة مع P<0.05

الاستنتاج:تعد هجرة الأقفاص القطنية إما بهبوطها بالفقرة أو إزاحتها إلىالقناة الشوكية من العوامل التي تؤدى إلى فشل جراحة التحام الفقرات القطنية. وقد أوضحت الدراسة أن هناك عدة عوامل تؤدى إلى ذلك. ووجدت الدراسة أن حالات هبوط القفص العالية أو الإزاحة تحتاج إلى التدخل الجراحي لإعادة القفص في حين يمكن التعامل مع الانخفاض البسيط للقفص بطريقة تحفظية دون تدخل جراحي. ولا يزال إتباع نهج آمن لإزالة القفص آمرا يشكل صعوبة بالتدخل الجراحي. ووجدت الدراسة أن النهج الخلفي الجراحي آمن وفعال لمراجعة القفص المهاجر.