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Interbody Fusion. Is It Has a Rule in Broken Screws in Surgical Management of Lumbar Spondylolisthesis?

Micheal Zohney[1], Ahmed Sawy[1], Nazek Ahmed[1], Hamdi Nabawi Mostafa[2]*

[1]Department of Neurosurgery, Nasser Institute for Research and Treatment, Cairo,
[2]Department of Neurosurgery, Faculty of Medicine, Misr University for Science and technology, Giza,
*Corresponding Author: Hamdi Nabawi Mostafa, Email: hamdi.nabawy@gmail.com, Tel: +201223932347

ABSTRACT

Background: for many years, posterolateral fixation for lumbar spondylolisthesis by using pedicle screw has been the standard procedure for lumbar spondylolisthesis. For increasing fusion and anterior support, the interbody fusion, either with cage or bone, were used by many surgeons, one of the most disappointing complications of pedicle screw fixation is broken screw.

Aim: it was to compare the number of cases with a broken screw in case of interbody fusion and control group.

Patients and Methods: this is retrospective cohort study in six years comparing between two groups: Group I posterolateral fixation (PLF), Group II posterolateral interbody fusion (PLIF). it analyzed 26 cases of broken screw occurred in six years from 2010 to 2016 which were done in Nasser Institute by the same surgeon and same system.

Results: twenty-six cases were reviewed, the mean age was 44.6 years, female : 6/26 (23%), male : 20/26 (77%),mean weight: 74.8 kg, site for broken screw: (L1: 4 patients – L2: 2 patients – L3: 2 patients – L4: 4 patients – L5: 6 patients – S1: 8 patients), 6 patients had broken screws following trauma, while 20 patients were found spontaneous, all patients were found intraoperatively to have posterolateral fixation, they underwent redo screw fixation,18 patients underwent redo screw fixation with posterolateral interbody fusion (PLIF) while the other 8 patients underwent redo screws fixation with posterolateral fixation. All patients with PLIF didn't come back with broken screws, while 2 patients with posterolateral fixation came back with broken screws again

Conclusion: posterolateral interbody fusion (PLIF) may have a rule in preventing broken screw in the management of lumbar spondylolisthesis.

Keywords: Spondylolisthesis, Posterolateral fixation (PLF), posterior lumbar interbody fusion (PLIF), broken screw.

INTRODUCTION

Spondylolisthesis is a condition characterized by a failure of the three column support with severe complex instability requiring reconstruction of the altered supporting structures [(1,2)].

In the past 40 years, a wide variety of spinal instrumentation was developed for treating spondylolisthesis. The fusion rate was found to improve with the use of internal fixation using transpedicular screw fixation that allowed segmental fixation of the spine for treating spondylolisthesis [(2)].

The use of posterior lumbar pedicle screw instrumentation is now the standard for reconstruction of the affected segment; its widespread application introduced the era of segmental spinal fixation [(3)].

Posterior lumbar interbody fusion (PLIF) has been used in management of spondylolisthesis especially of isthmic type [(2,3)]. The goal of lumbar fusion is to obtain solid fusion so as to alleviate pain. Unlike the posterolateral gutter fusion, the PLIF

achieves spinal fusion in the low back by inserting a cage made of either allograft bone or synthetic material (peek or titanium) directly into the disc space[(4)].

Pedicle screw breakage is reported to occur in 1-11.2% of inserted screws and in 0.4-24.5% of patients [(5,6)]. This implant failure can be a result of pseudarthrosis and can lead to pedicle screw or rod breakage. Appropriate radiographs can demonstrate the screw breakage and revised spinal surgery is the mainstay of treatment when there is a broken pedicle screw[(4–8)].

PATIENTS AND METHODS

This study was retrospective cohort study in six years to analysis single factor in implant failure, which is comparing the number of cases with broken screw between two surgical techniques Group I: posterolateral fixation (PLF), Group II: posterolateral interbody fusion (PLIF) and the results of revisions of cases by both techniques.

Between January 2010 and January 2016, at Nasser Institute for Research and Treatment, Ministry Of Health, a total of 432 patients have done posterior lumbar fixations of which 322 patient did posterolateral fixation (PLF) and 110 did posterior lumbar interbody fusion by synthetic material (peek), reported cases of implant failure were 26.

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Inclusion criteria required all patients did either PLF or PLIF due to segmental instability either isthmic or degenerative spondylolisthesis, grade one or two spondylolistheses on clinical and radiological basis. All patients had been done by the same surgeon, the system used was supplied by local company and it is the same in all cases and also in revisions of implant failure.

Exclusion criteria were patients fixated due to acute spinal fracture, severe osteoporosis, immune suppression, malignancy, active local and/or systemic infection, morbid obesity as measured by body mass index > 40, and patients with spondylolisthesis of grade higher than grade 2.

We revise every case of the implant failure by reviewing history that was taken in primary and secondary admission, the history of trauma after primary fixation, follow up X-ray after 1,3,6, months and one year.

The study was approved by the Ethics Board Misr University for Science and technology.

Surgical technique

All patients were operated using midline posterior skin incision and subperiosteal retraction of paraspinal muscles to expose the affected segment, and in recurrent cases removal of scar tissue. The mobile lamina was removed and decompression was done as necessary. Nerve roots are exposed and decompressed [(3)].

In all patients' pedicle screws were inserted, and their correct positions were confirmed by AP and lateral fluoroscopy. In PLF group, after adequate decompression, the bed for graft was prepared. Subperiosteal dissection was performed between the transverse processes and lateral aspects of facet joints. The fusion bed is prepared by decortication of the transverse processes and removed lamina is used as bone graft. In PLIF group, an annulotomy was performed then disc debridement was achieved by use of disc shavers[(5)]. Completion of total discectomy was performed by using a combination of standard disc rongeurs, disc shavers, and curettes. Implant channels were prepared using PLIF reamers to flatten the vertebral endplate, removing the posterior concavity and leaving most of the endplate intact [(4-5)]. Peek cage filled with an autogenous bone graft from the removed lamina was packed as tightly as possible into the disc space. Final rods of the desired length were contoured to the appropriate lordotic curve and applied over the pedicle screws. A drainage catheter is inserted. Facial, subcutaneous, and skin layers are closed [(3)].

RESULTS

This study included 432 patients. The first group operated by PLIF contained 110 patients. Second group operated by PLF contained 322 patients.

Of the whole 432 patients, 26 (6%) cases showed broken screws, 24 patients with broken screws were operated by PLF technique, while 2 patients operated by PLIF showed broken screw as a complication.

The average age of patients with broken screws was 44.6 years old. They were 20 males and 6 females. Average weight was 74.8 Kg.

After taking history of each patient, 23% (6 patients) showed a history of trauma, 77% (20 patients) did not have any history of trauma before screws broke. 2 cases of broken screws were in PLIF group, both cases showed history of trauma.

Table 1: Number of broken screws for each group

	Number of broken screw with previous history of trauma	Number of broken screw with no previous history of trauma
PLF	4	20
PLIF	2	0

The percentage of broken screw was highest for the first sacral screw by 30.7%, Lowest at first and second lumbar vertebrae by 7.7% for each. And it was 15.3% for screws at third lumbar vertebrae, 23% of screws were from forth lumbar vertebrae.

Table 2: Number of broken screw cases for each level

Level of broken screw	Number of cases
L1	4
L2	2
L3	2
L4	4
L5	6
S1	8

Revision operation was performed for the 26 cases, 18 of cases re-operated by PLIF, 8 of cases operated by 8 PLF. Patients were followed up for 6 months after second operation, no patients re-operated by PLIF showed a complication of broken screw again, while 2 cases of 8 re-operated by PLF showed broken screw again. And they undergo a third surgery to perform PLIF. Figure 1 is a representative case from our case series.

Table 3: Technique used for redo surgery		
	PLF	PLIF
Technique of redo operation	8/26	18/26
Broken screw after redo	2/8	0/18

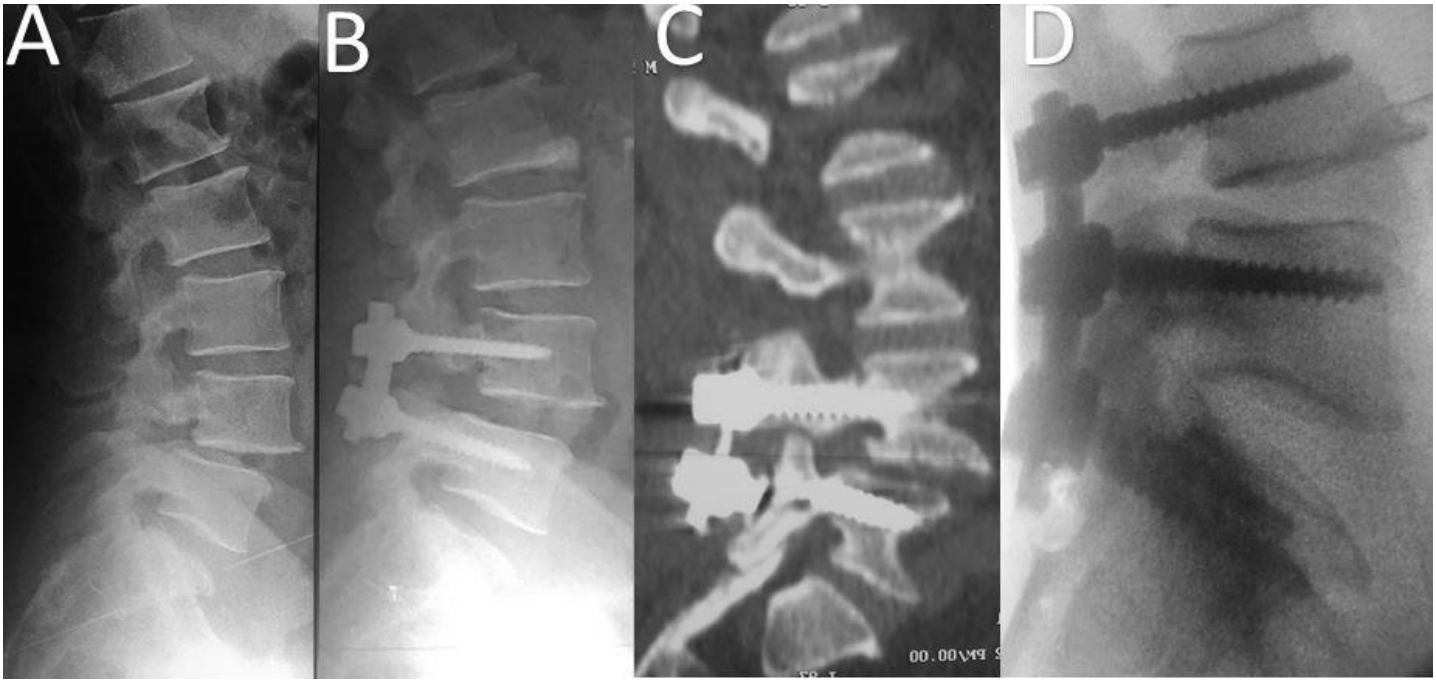

Figure 1: A; X-ray lateral view of patient with spondylolisthesis before first operation. B; X- ray lateral view showing patient after first operation with good insertion of 4 pedicle screws (PLF). C; Sagittal CT for the same patient after spontaneous broke of the fifth lumbar pedicle screw. D; X- ray lateral view of the same patient after another PLF with added sacral screws.

DISCUSSION

By using cadaveric specimens, Crawford ***et al.*** [9] reproduced the lumbar spondylolisthesis grade I and studied the biomechanics of various hardware combinations including cages with and without intersomatic spacers, pedicle screws alone, and pedicle screws with cages. Pedicle screws with cages presented better biomechanics in flexion, axial rotation, lateral extension, and shear forces. The authors suggest the use of screw systems and cages in grade I lumbar spondylolisthesis patients because the greater stability may allow for good fusion around the cages [9,10]. van Dijk ***et al.*** [12,13] reported a biomechanical advantages and clinical safety with the use of interbody fusion with a cage.

The large the surface area of decorticated vertebral endplate for fusion, the greater the contact area exposed to support a spinal fusion. PLIF can offer a larger surface area for fusion than PLF[14].

Lei Cheng ***et al.*** [14], Brantigan ***et al.*** [15] and Brantigan ***et al.*** [16] also found that if posterior pedicle fixation was used in combination with an interbody fusion cage, the incidence of cage subsidence was significantly lowered and the fusion rated increased.

Yong-Ping Ye et al concluded that PLIF treatment provided significantly better fusion rates than PLF treatment [16].

Dantas *et al.*[16] concluded that both PLF and PLIF were effective. The PLIF with pedicle screws group presented better clinical outcomes. PLF presented more complications when compared with PLIF. PLIF presented better results as indicated in the Prolo economic and functional scale. The results of our study were similar to the findings of Dantas [17].

Kim et al. compared three fusion methods: posterolateral fusion (PLF), posterior lumbar interbody fusion (PLIF), and PLIF combined with PLF (PLF+PLIF), and reported that no significant differences in clinical results and union rates were

found among the three methods. PLIF had better sagittal balance than PLF [18].

In our study, PLIF showed lesser rate of broken screws than PLF. We refer this high rate of broken screws in PLF technique to failure of fusion due to lesser decorticated bone in this group. Also, the biomechanical stress in PLIF group is distributed among posterior, middle and anterior columns by the cage and screws, while it is concentrated in the screws and rods in PLF group.

Also, PLIF screws need a huge amount of stress (trauma) to be broken, while no spontaneous broken screw had been noticed in PLIF group [16,18].

Conclusion:

We conclude that if there is instability affecting the three-column spine in spondylolisthesis, posterior interbody fusion with pedicle screws (PLIF) provides a less broken screw rate when compared with the pedicle screws used alone. The PLF group showed more complications related to hardware biomechanics.

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