

# Percutaneous Pedicle Screw Fixation Versus Open Pedicle Screw Fixation: Pros and Cons

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## Abstract

**Objectives:** Comparing the outcomes of open versus percutaneous trans-pedicular screw fixation in patients with various thoraco-lumbar pathologies as regards post-operative back pain and fusion rates.

**Methods:** 180 patients were collected and divided into two groups, Group A with 97 patients who underwent open fixation, and 83 patients who underwent percutaneous fixation were gathered in Group B. Clinical outcomes were collected from both groups as regards back pain, hospital stay, resolution of presenting symptoms and rates of spinal fusion.

**Results:** Post-operative back pain was encountered in all of our patients, but with a higher visual analogue score (VAS) in the patients with open surgery for the first two weeks after surgery. Short and long term follow ups shows no superiority of one technique over the other as regards hospital stay, back pain, or resolution of symptoms. Rates of spinal fusion were more prominent in open cases with posterolateral fusion, however, in cases of post-traumatic spinal fixation, fusion rates were comparable in both groups with percutaneous surgeries more superior being less invasive.

**Conclusions:** Minimally invasive Percutaneous fixation provides early post-operative recovery with rapid mobility and tolerable back-pain. However, on the long-term, the low rates of fusion is still the weak-point favoring the classic open technique with comparable residual back pain after 6 months in both techniques.

## INTRODUCTION

Pedicle screw systems provide spinal stability by engaging all three columns of the spine and can resist motion in all planes. Several studies suggest that pedicle screw fixation is a safe and effective treatment for many spinal disorders including: spondylolithesis (isthmic and degenerative) and in some cases of lumbar canal stenosis, lumbar disc prolapse, dorsal/lumbar spinal fractures (traumatic and neoplastic) and spondylodiscitis. (1,2) Surgical approaches using minimally invasive technique including percutaneous pedicle screw fixation are becoming more widespread in spine surgeries. (3) Reducing soft tissue and muscle disruption, decreasing blood loss, shorter hospital stay, and lower rates of post-operative complications, all were among suggested advantages of percutaneous over open fixation, whereas lower rates of spinal fusion were expected. (4) In our study we are providing our comparative experience on 180 patients who were operated by open and percutaneous trans-pedicular thoraco-lumbar spine fixations.

## PATIENTS AND METHODS

### Patients

Over a period of 4 years (September 2014-October 2018), we performed a prospective randomized analytical study on 180 patients with various dorsal/lumbar pathologies (degenerative, traumatic or neoplastic) in which trans-pedicular screw fixation was mandatory. Our population was randomly divided into two groups: Group A with 97 patients (54%) who underwent open fixation, and Group B with 83 patients (46%) who underwent percutaneous fixation, Table 1 summarizes patients demographic data and diagnosis. Clinical outcomes were collected from both groups as regards: back pain as measured by visual analogue score (VAS), hospital stay, resolution of presenting symptoms and rates of spinal fusion as confirmed by post-operative CT scans after 6 months, one year and two years after surgery.

### Surgical Procedures

All surgical procedures were performed by the same group of surgeons (authors). Patients were placed on radiolucent tables in prone position.

### **Group A (Open Fixation):**

A standard posterior midline incision was made from the upper end of the spinous process two levels above the uppermost targeted pedicle to the lower end of the lamina of the lowest instrumented vertebra. Sub-periosteal cautery dissection of supraspinous ligament and paraspinous muscles was done exposing the lamina, then dissection was carried down over the lateral margin of the superior facet onto medial margin of the transverse process. Exposing the entry points of pedicular screws, then C-arm guided screw insertion was done. (3,5) Then correction of pathology was done: laminectomy, discectomy, or decompression, followed by insertion of rods and postero-lateral fusion with bone graft.

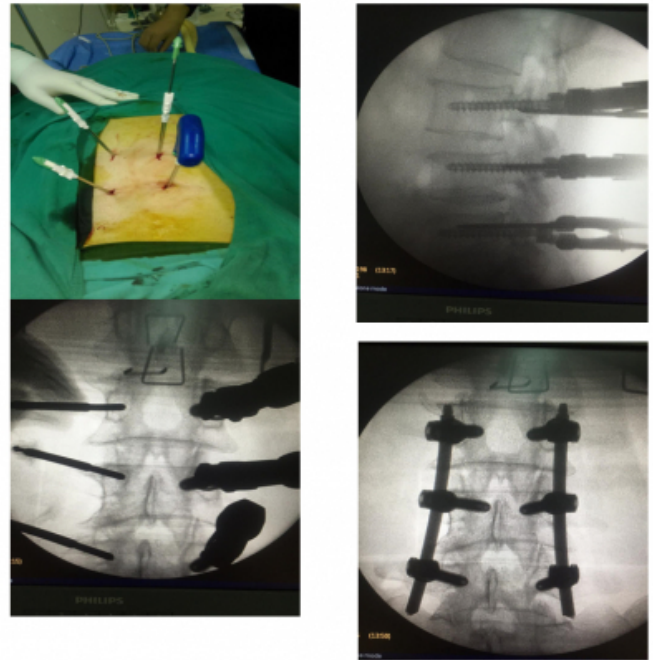
### **Group B (Percutaneous Fixation):**

As mentioned by Kim et al (2004) (3), for inserting a percutaneous pedicular screw, under fluoroscopic guidance in AP view, a small incision was made with a No. 11 scalpel blade the, disposable 11-gauge bone marrow needle was positioned with its tip on the supero-lateral margin of the targeted pedicle and advanced until the stylet tip performs a small depression in the cortex before the image was rotated to the lateral view. The needle is advanced through the cortex by tapping its back end with a hammer under lateral view. The lateral view showed the needle passing in mid-pedicle parallel to the superior and inferior edges till the body of the vertebra at the junction of the middle and posterior third. A 1.8-mm K-wire was exchanged through the needle and the skin incision was extended to allow passage of dilators. With the K-wire still in place, a hole was drilled in the pedicle using a 5.0-mm cannulated drill followed by a pedicle screw into the prepared hole with the same orientation as the wire under the fluoroscopic guidance.

Then surgical management of the pathology was done via midline incision (laminectomy, discectomy or decompression).

**Figure 1**

A case operated for Percutaneous Fixation.



## RESULTS

180 patients with various spinal pathologies were operated for lumbar spinal fixation, 97 (54%) were operated by open fixation (Group A) and the remaining 83 patients (46%) were by percutaneous fixation (Group B) as illustrated below in Table 1.

Most cases in both groups were isthmic spondylolistheses: 67% from Group A (65 cases) and 58% of Group B (48 cases), followed by Post-Traumatic Spine fractures which involved 24 patients among group B (29%) while 17 patients were in Group A (17%).

Twenty-one patients with degenerative spondylolisthesis were involved, 12 among group A (12%) and 9 among group B (11%). Three cases with spinal neoplasm in Group A and 2 cases from Group B.

**Table 1**

Demographic data and diagnoses

<i>Group A (Open fixation)</i>	
	No.
Total	97 (54%)
Males	41 (42%)
Females	56 (58%)
Age	33-67 (mean 50)
<b>Diagnoses</b>	
Isthmic Spondylololthesis	65 (67%)
Degenerative Spondylololthesis	
Post-Traumatic	12 (12%)
Neoplastic	17 (17%)
	3 (3%)
<i>Group B (Percutaneous Fixation)</i>	
	No.
Total	83 (46%)
Males	37 (45%)
Females	46 (55%)
Age	24-78 (mean 51)
<b>Diagnoses</b>	
Isthmic Spondylololthesis	48 (58%)
Degenerative Spondylololthesis	
Post-Traumatic	9 (11%)
Neoplastic	24 (29%)
	2 (2%)

From Group A, 89% of cases operated by open fixation showed highly significant resolution of presenting symptoms (sciatica, claudication, back pain, neurological deficit etc...) ( $P < 0.001$ ) nearly comparable to the results obtained from Group B being 90%.

While immediate post-operative highly significant back pain, with the highest score in VAS, was the main complaint in 100% of patients ( $P < 0.001$ ) who underwent open fixation (Group A), and it was a significant complaint of 83% of group B ( $P$  value 0.0223), our post-operative follow-up showed comparable results in back-pain one and six months.

One month after surgery, 76% of group A still complained of significant residual back pain ( $P$  value 0.033) that limited their routine daily activities, while it was in 72% of cases in Group B ( $P$  value 0.041). When comparing results 6 months later, only 17.5% of Group A ( $P$  value 0.998) and 14.5% of Group B ( $P$  value 0.881) had non-significant residual back

pain and they continued on analgesics and muscle relaxants.

As regards spine fusion, post-operative CT scans done after 6 months showed significantly higher rates of fusion in cases of Group A (86%) ( $P < 0.001$ ) while only 30% ( $P$  value 0.602) of cases in Group B showed spinal fusion which mainly occurred successfully in cases with recent spinal fractures (22 out of the fused 35 patients of Group B).

Table 2 below illustrates the post-operative clinical and radiological out-comes.

Table 2

Clinical Outcome

### Group A (Open fixation)

		No.
Resolution of presenting symptom	of	87 (89%)
<b>Post Operative Back Pain (VAS)</b>		
• Immediate		97 (100%)
• One month		74 (76%)
• 6 months		17 (17.5%)
Lumbar Fusion	Spinal	83 (86%)

### Group B (Percutaneous Fixation)

		No.
Resolution of presenting symptom	of	75 (90%)
<b>Post Operative Back Pain (VAS)</b>		
• Immediate		69 (83%)
• One month		60 (72%)
• 6 months		12 (14.5%)
Lumbar Fusion	Spinal	25 (30%) (22 of which were post-traumatic cases)

## DISCUSSION

Several studies in literature have been discussing the advantages of minimally invasive percutaneous trans-

pedicular spinal fixation over the traditional open technique, by providing less muscle damage, less blood loss with shorter duration of surgery, as well as, early mobility and shorter hospital stay (1,2,3,4,5).

One of the important factors that has high influence on patients' post-operative quality of life is the residual back pain. In our study we compared the early and late post-operative back pain in patients with various thoraco-lumbar spinal pathologies who have underwent spinal fixation, one group was operated by open and the other group was by percutaneous trans-pedicular screw fixation.

Early post-operative results of back pain showed statistically significant differences between both groups favoring the percutaneous fixation. With minimal incisions and limited muscle trauma, back pain was tolerated by most of our patients who showed lower visual analogue scores in the first post-operative few days with better mobility and rapid rehabilitation. Similar results were expressed in previous literature applauding the minimally invasive percutaneous trend. (1,4,6)

However, when following up our patients after 1 and 6 months post-operative, we discovered that with complete muscle and bone healing, no technique has an upper-hand over the other as regards residual back pain, with insignificant differences between both groups.

The aim of surgery for spinal fixation is to maintain stability and provide immobilization favoring fusion (inter-body or postero-lateral), this is not the case in the percutaneous fixation; rates of fusion of our cases showed statistically significant difference favoring the open technique. It is well established in literature: percutaneous fixation carries high rates of non-union (6,7).

With further analysis, we found that 88% of patients who achieved fusion in the percutaneous group were the cases of spinal fractures. Phan et al (4) mentioned in their systematic review that there were no significant differences in the clinical and radiological outcomes of patients with thoraco-lumbar fractures who were operated by open or percutaneous fixation, which is in favor of the minimally invasive procedure in this particular subgroup, i.e. minimally invasive percutaneous fixation is the optimum management for thoraco-lumbar spine fracture patients, specially those who are neurologically free. (4,8)

On the other hand side, we believe that degenerative spinal diseases that require fixation and fusion are better

managed with the open technique providing wider surgical field with better visualization of pathology (stenosis, prolapsed disc, etc...), less x-ray exposure, as well as long term higher rates of fusion.

It is worth mentioning that we preferred the percutaneous minimally invasive technique for our elderly patients with medical co-morbidities complaining of various spinal pathologies; with limited blood loss, limited anesthesia time, shorter hospital stay and rapid rehabilitation, this minimally invasive technique is believed to be favorable by providing spinal stability while dealing with patients having co-morbidities in which open-surgery might be of high risk. Similar conclusions are mentioned by Barbagallo et al (6) after their study on elderly patients with degenerative spinal diseases who required fixation.

Fusion in percutaneous fixation is still the weak-point of this trending procedure, further studies and clinical trials are needed to provide solutions and/or alternatives.

### **CONCLUSIONS**

Minimally invasive percutaneous fixation provides early post-operative recovery with rapid mobility and tolerable back-pain. However, on the long-term, the low rates of fusion are still the weak-point favoring the classic open technique with comparable residual back pain after 6 months in both techniques.

Percutaneous fixation is optimum for thoraco-lumbar spinal fractures and for elderly patients who have co-morbidities necessitating less anesthesia exposure and shorter hospital stay.

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