5f TRANSLAMINAR FACET SCREW FIXATION

Kamil Cagri Kose M.D., Isador H. Lieberman M.D.

1. Introduction:

Although the new era in spine surgery is highly focused on preserving mobility, fusion is still an accepted way of treatment for a variety of spinal disorders. To stabilize the spine until a fusion consolidates, spine surgeons have used combinations of hooks, wires and pedicle screws. The main problem with these implants is the need for an extensive soft tissue dissection which potentially contributes to increased number of and more significant complications. To implant pedicle screws in a safe and anatomically correct position, the proximal facet joint of the segment to be fused needs to be exposed and may well be damaged by the screw. In addition, pedicle screw constructs are expensive and the screws and rods form a bulky hardware mass in the back of the patients, which may be disturbing and lead to implant removal which means another operation.

The use of translaminar facet screws may eliminate many of these issues. Contrary to popular belief facet screw fixation is not new. King described his method of transfacet fixation as early as 1948 [(1)]. This technique was modified by Boucher in 1959 [(2)]. Both techniques were transfacet but not translaminar. Magerl in 1984 revised a new transfacet screw fixation technique which was also truly translaminar [(3)]. He used the contralateral side of the spinous process as the starting point of drilling for this procedure. The use of this implantation trajectory increases screw length and the potential stability of the fixation. In addition to decreased operative costs, the application of this technique required a limited soft tissue dissection only to the outer side of the facet joint and required only exposure of the facet joint of the involved level. The implants are not bulky and are less likely to disturb the patients. The earlier applications were performed by using 4.5 mm regular cortical bone screws but today special sets are designed for this technique.

With the advent of less invasive surgical techniques and increased imaging and guidance capabilities translaminar screws can be employed in a much less invasive fashion through small stab wounds [(4)].

2. Indications:

a) Degenerative conditions with a stable anterior column (degenerative listhesis, stenosis, segmental instability).

b) Posterior stabilization after interbody reconstruction.

c) To provide additional contralateral fixation in thoracolumbar fractures treated with unilateral posterior instrumentation [(5)].

3. Contraindications:

The contraindications of the translaminar facet screw fixation are:

a. Isthmic spondylolysis or listhesis greater than grade 1.

b. Deficient posterior elements (lamina and spinous process)

c. Anterior column deficiency

d. Severe osteoporosis

4. Surgical Procedures:

4.a. Surgical Equipment:

Although there are specifically designed sets {(Universal Cannulated Screw Set [UCSS]; Sofamor-Danek) or The Discovery Translaminar Facet Screw Set (DePuy AcroMed, Raynham, MA)}, this procedure was originally performed and still can be with standard 4.5 mm cortical bone screws.

4.b. Patient Positioning:

The patient position is prone on a typical spinal surgery frame to facilitate the exposure and any use of guidance or fluoroscopy. The preparation and draping is completed with the surgeon's typical preference. Intra-operative fluoroscopy or plain radiographs are used to identify the level of concern and may also be used throughout the operation to judge positioning of the implants (Figure 1).

4.c. Surgical Technique:

The technique utilizes a basic less invasive exposure approach. Although the application of translaminar screws may be accomplished with fluoroscopically guided less invasive applications, for the first few cases, we recommend some experience with an open approach to gain familiarity with the anatomy and with the "feel".

Through a small vertical midline incision, the spinous processes, laminae and the facet joints are exposed in a standard fashion. If decompression is needed, care should be taken to preserve the laminar arch and 50% of the facet joints. Consideration may even be given to first implanting the screws then proceeding with the decompression. Once exposed, the facet capsule is opened and the joint surfaces are denuded of their cartilage. Bone graft of the surgeons's choice is then packed into the facet joint.

Figure 1:
Patient positioning for the translaminar facet screw fixation.

A 3.2 mm drill bit is used to drill the base of the spinous process towards the facet joint. This drilling can be done through the incision or through a second stab opening. It should be remembered that in order to place 2 screws through one spinous process, without the screws hitting each other, one screw should be placed a bit more caudal and the other a bit more cranial. If the trajectory of the lamina is followed the risk of penetrating the epidural space is minimal and the risk of injuring the dura or neural structures is negligible. After drilling with the 3.2mm drill bit a 4.5mm tap is used to tap the hole and then the length of the hole should be measured with a dept gauge. Finally an appropriate length 4.5 mm screw is placed across the facet joint through the hole in the lamina (Figure 2a, b, c). The translaminar screw is not meant to be a lag screw; it is a stabilization neutralization screw. As such compressing the facet joint will only result in either facet fracture or spinous process fracture.

Anterior vertebra corpus support or instrumentation is necessary for most of the cases additional to the translaminar facet screw fixation. Anterior femur bone graft insertion via anterior abdominal approach into the disc space increase the stabilization of the vertebrae. The anterior bone graft may stabiliza with an additional screw into the inferior or posterior vertebra corpus (Figure 3a, b, c) (Figure 4a, b, c, d).

5. Postoperative Care:

There is no need for a special postoperative care. The patient is generally discharged in 1-2 days. A neoprin lumbar corset can be used to provide immobilization for 4-6 weeks. Return to work s generally dependent on the patient motivation and job specifications.

6. Complications and Avoidance:

Although translaminar facet screw fixation is a relatively simple fixation technique, as with all surgical procedures, it is not free of complications. The potential complications include:

a) Foraminal violation and nerve root irritation by the drills or tools if the trajectory is not ideal or by screw malposition. In this case, if the imaging studies show impingment of the nerve root, the screw should be removed and replaced (either using an open or percutaneous approach)

b) Inadequate decompression:

The spine surgeon should never sacrifice a good decompression in order to preserve bone for fixation. If too much bone is resected other methods of spinal fixation should be employed.

Regardless of the type of complications the patient should be informed prior to the procedure about

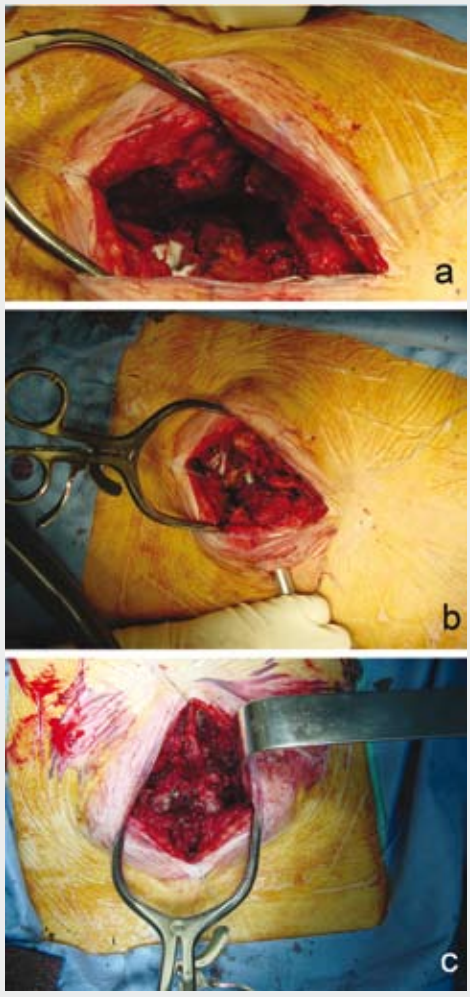

Figure 2:
Intraoperative views showing: **a)** exposure of the laminae and posterior structures of the vertebrae **b)** placement of the working cannula through the lamina.**c)** final position of the bilateral translaminar screws.

the possibility of converting to transpedicular instrumentation. If the surgeon feels uncomfortable while redirecting a malpositioned screw, or is concerned about doing an inadequate decompression, conversion to transpedicular instrumentation is the appropriate alternative

7. Clinical Studies:

There are increasing reports about the clinical and biomechanical outcomes of translaminar facet screw fixation.

Below are various clinical studies about TLFS fixation and their clinical results:

Author/year	No of patients	Follow-up	Clinical result	Fusion Rate	Fusion Time	Complications
Jacobs et al 1989 [6]	43	16 mo	93% improvement	91	6 mo	None neurological
Grob et al 1992 [7]	72	24.4 mo	76% satisfied	94.5	-	Screw breakage-5 5 screws were not transfacet Discitis 1 Back pain 2 Dural tear 1 Wrong level 1 None neurological
Reich et al 1993 [8]	61	24 mo	93.4 % excellent to good, 6.6% unsatisfied	98.4	5 mo	None neurological
Grob et al 1998 [9]	173	68 mo	99 good, 70 satisfactory, 4 bad	94	-	3%loosening, Screw breakage 2 Discitis 1 Dural tear 1 Temporary quadriceps weakness 1 Wrong level 1 Nerve root irritation 1
Thalgott et al 2000 [10]	46	24 mo	75.5% good, excellent or total pain relief	93.2		None neurological
Yin et al 2004 [5]	30	10 mo	97% anterior, 98% posterior edge restoration	100%	4.3 mo	%3.4 correction loss
Best et al 2006 [11]	43	>24 mo	-	95.3%	-	4.7% reoperation
Jang et al 2003 [12]	18	6 mo	100% excellent or good	-	-	No malpositions and no other complications
Shim et al 2005 [13]	20	19.5 mo	80%good to excellent 20%fair to poor	100%		10.8% lamina violation, 15.4% minimal screw, malposition Articular process fracture in 1 level

Figure 3:
a) The AP X-rays
b) lateral X-rays and
c) sagittal MRI images of a patient with L4-5 degenerative disc disease.

It can be seen from the table that translaminar facet screw fixation has proven to be a safe method of posterior stabilization with high rates of fusion.

8. Future Perspectives:

Following the minimally invasive trend in the whole world, spine surgeons also have gained interest into these methods. As new types of minimally invasive procedures evolve, surgeons face new complications. Decreasing invasiveness of these procedures can only be accomplished by increasing the safety and accuracy of these techniques.

Three dimensional fluoroscopy navigation systems have been used for these purposes. These still rely on the interpretation of the digital data by a machine and application of the procedure by the surgeon. There still exists a way for a mistake as final mechanical application is made buy the surgeon.

In order to decrease the error at the mechanical phase of these surgeries robotic guidance systems which direct the surgeon to a further step in the operation are being developed. So far the test results are promising and demonstrate a safe method of inserting pedicle screws and translaminar facet screws.

In the near future we believe that the robotic guidance systems will be available in our daily practice to increase the safety and accuracy of these surgeries [14-16].

9. References:

1. King D. Internal fixation for lumbosacral fusion. J Bone Joint Surg Am 1948; 30: 560-5.
2. Boucher HH. A method of spinal fusion. J Bone Joint Surg Br 1959; 41: 248-59.
3. Magerl FP. Stabilization of the lower thoracic and lumbar spine with external skeletal fixation. Clin Orthop 1984; 189: 125-41.
4. Shim CS, Lee SH, Jung B, Sivasabaapathi P, Park SH, Shin SW. Fluoroscopically assisted percutaneous translaminar facet screw fixation following anterior lumbar interbody fusion: technical report. Spine 2005; 30(7): 838-43.
5. Yin QD, Zheng ZG, Cai JP. Pedicle screw fixation with translaminar facet joint screws for the treat-

ment of thoracolumbar fracture. Chin J Traumatol 2004; 7(6): 354-7.
6. Jacobs RR, Montesano PX, Jackson RP. Enhancement of lumbar spine fusion by use of translaminar facet joint screws. Spine 1989; 14:12–5
7. Grob D, Rubeli, Scheier HJ, Dvorak J. Translaminar screw fixation of the lumbar spine. Int Orthop 1992; 16: 223–6.
8. Reich SM, Kuflik P, Neuwirth M. Translaminar facet screw fixation in lumbar spine fusion. Spine 1993; 18: 444–9.
9. Grob D, Humke T. Translaminar screw fixation in the lumbar spine: technique, indications and results. Eur Spine J 1998; 7: 178–86.
10. Thalgott JS, Chin AK, Ameriks JA, Jordan FT, Giuffre JM, Fritts K, Timlin M. Minimally invasive 360 degrees instrumented lumbar fusion. Eur Spine J 2000; 9 (Suppl 1): S51-6.
11. Best NM, Sasso RC. Efficacy of translaminar facet screw fixation in circumferential interbody fusions as compared to pedicle screw fixation. J Spinal Disord Tech 2006; 19(2): 98-103.
12. Jang JS, Lee SH, Lim SR. Guide device for percutaneous placement of translaminar facet screws after anterior lumbar interbody fusion: Technical note. J Neurosurg 2003; 98(1 Suppl): 100-3.
13. Shim CS, Lee SH, Jung B, Sivasabaapathi P, Park SH, Shin SW. Fluoroscopically assisted percutaneous translaminar facet screw fixation following anterior lumbar interbody fusion: technical report. Spine 2005; 30(7): 838-43.
14. Lieberman IH, Togawa D, Kayanja MM, Reinhardt MK, Friedlander A, Knoller N, Benzel E: Bone-Mounted Miniature Robotic Guidance For Pedicle Screw and Translaminar Facet Screw Placement; Part I - Technical Development and a Test Case Result. Neurosurg 2006; 59 (3): 641-650.
15. Togawa D, Lieberman IH, Kayanja MM, Reinhardt MK, Friedlander A, Knoller N, Shoham M, Balter A, Benzel E: Bone-Mounted Miniature Robotic Guidance For Pedicle Screw and Translaminar Facet Screw Placement; Part II – Evaluation of System's Accuracy. Neurosurg 2007; 60 (2 Suppl 1): 129-39.
16. Shoham M, Lieberman IH, Benzel EC, Togawa D, Zehavi E, Zilberstein B, Roffman M, Bruskin A, Fridlander A, Joskowicz L, Brink-Danan S, Knoller N. Robotic assisted spinal surgery--from concept to clinical practice. Comput Aided Surg 2007; 12(2): 105-15.

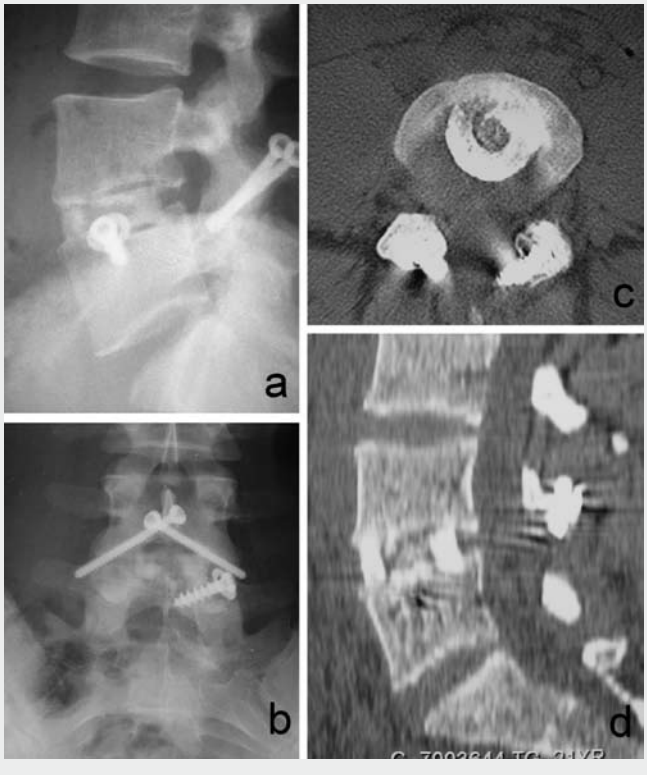

Figure 4:

Postoperative follow-up views of the same patient

a) Lateral X-ray

b) AP X-ray showing the translaminar fusion system with anterior interbody bone graft support.

c) Axial and

d) Sagittal CT image showing solid fusion of both endplates through the interbody bone graft.