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Editorial

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Minimally invasive percutaneous fixation of thoracolumbar fractures: where do we stand?

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Abstract

Thoracolumbar fractures are associated with high-energy trauma, most of them involving the thoraco-lumbar transition. Their surgical treatment is made with the purpose of stabilizing the spine and at the same time to correcting its alignment. Open fixation of these fractures leads to good outcomes but is associated with important comorbidity as significant blood loss and post-operative infection. Percutaneous fixation reduces soft-tissue damage and is unable to result in a true spinal fusion. But recent studies have shown its potential in leading to equivalent postoperative Cobb angle, postoperative vertebral body angle correction loss and postoperative vertebral body height correction loss. On the other hand, surgical treatment of thoracolumbar fractures by percutaneous instrumentation provides accurate placement of pedicle screws and leads to better functional and radiological outcomes.

Editorial

Fractures of thoracic and lumbar spine are a spectrum of injuries ranging from simple undisplaced fractures to complex fracture dislocations. Almost 60% of spinal fractures occur in the thoracolumbar region (T11-L2).[1]They are usually caused by the failure of both the anterior and middle columns of the vertebral body under axial compression loads with or without flexion forces.[2]

The traditional open approach in the surgical treatment of thoraco-lumbar fractures is associated with satisfactory clinical outcomes, mainly fracture reduction and deformity correction.[3]

However, open fixation is associated with significant perioperative morbidity as it increases intra-operative blood loss and prolongs hospital stay. There are also studies showing higher infection rates, more paraspinal muscle damage and longer operative time.[4,5]

Moreover, the open approach damages the ending point of the multifidus muscle bound, which affects the function of the muscles and limits waist torsion, leaving the patients unable to stand by themselves and thus increasing the risk of bedsores and other complications.[6,7] These result in sustained back pain or back muscle dysfunction.[8]

The current trends toward minimally invasive surgical techniques represent an important shift in the practice of contemporary spinal surgery. Minimizing the skin incision and the muscle and bone damage are key factors of these procedures. Magerl[9,10] initially reported the first use of percutaneous pedicle screw insertion instrumentation in 1977 and later re-emphasized it in 1984.

Percutaneous screw fixation has been increasingly used after Assaker reported promising results of this procedure in thoracolumbar trauma.[11] The concept evolved over time and was supported by technological improvements such as intraoperative 3D computer tomography, navigation systems and screw improvements.[12] Intraoperative and postoperative blood loss, recovery time and postoperative back pain are minimized in percutaneous fixation due to smaller incisions and less paravertebral muscle damage.[13] Both operative time and intraoperative fluoroscopy length are less when using the percutaneous approach.[14,15]

On the other hand, minimally invasive approach has benefits such as smaller scars, diminished local pain, reduced postoperative wound pain and shorter hospital stays. The average length of stay was only 1, 5 days in a study published in 2015.[16]

CK-MM (creatine phosphokinase isoenzyme), as a predictor of muscle damage, is significantly reduced in percutaneous approaches compared with open approaches. Extensive dissection and retraction do not only lead to paraspinal muscle denervation and atrophy, but also lead to additional damage from a thermal effect and ischemial.[13]

Although the immediate reduction ability of percutaneous approach is less than open approach, several studies found no differences over time in postoperative visual analog scale pain score (VAS), postoperative Cobb angle, postoperative vertebral body angle (VBA), VBA correction loss, postoperative vertebral body height (VBH) %, VBH correction loss, and screw misplacement between percutaneous and open surgery.[14,15,17,18] Pishnamaz et al. reported that the functional and the radiological outcome of both groups was comparable one year after the surgical treatment. Similarly, this study confirmed that as time went on, the functional and the radiological outcome of percutaneous approach would be better than with open approach, probably due to the integrity of ligamental structures, less damaged in percutaneous

surgeries.[19]

However, there are certain limitations and disadvantages in the percutaneous technique of fracture instrumentation. Additional repositioning by the device is highly limited compared to the open Schanz screw technique.[20] Also, the surgeon's experience in minimal invasive surgery should not be neglected: percutaneous technique has a long learning curve associated with a higher rate of the complications caused by screw placement in the early application.[21,22] To allow for pedicle screw angle variation, the limitation of percutaneous procedures is that they can only be used with polyaxial screws.[23]

Approximately 60% of the fixation strength of thoracic and lumbar pedicle screws is in the pedicle itself. The cancellous bone in the vertebral body adds another 15–20% of strength, whereas purchase in the anterior cortex offers 20–25% increase.[24] Percutaneous approach can result in a similar accuracy of screw placement compared with open approach, provided there is a reliable assistance of intra-operative radiation equipment.[14,25] The accurate placement of pedicle screws requires skill and experience, especially for the percutaneous insertion technique. Accurate placement of pedicle screws will provide optimal mechanical strength and patients' safety. According to a prospective trial published in 2013, percutaneous screw application for dorsal pedicle instrumentation is a safe and recommended procedure.[20]

Percutaneous pedicle screw instrumentation itself does not lead to bony fusion of the instrumented vertebral segments.[26] For a long time, compression fractures have been treated with immobilisation without grafting. Bone union is always obtained, thus not a concern. The true problem lies in the loss of correction, mostly in the disc but also in the vertebral body, due to insufficient mechanical strength. In fractures where the instability is bone-related (AO type B2 flexion-distraction fracture), the bone instability is temporary since the instability will not exist once union is achieved. This type of fracture does not require a bone graft. Thus, percutaneous fixation without grafting can be used to treat minimally displaced type A1 and A2 fractures, type A3 (but not A3.3) fractures and type B2 fractures.[27] Percutaneous screw fixation for type A3 thoracolumbar fractures without neurologic deficits are still controversial. Tian et al.[28] stated that fusion was not necessary when thoracolumbar burst fracture was treated by posterior pedicle screw fixation.

The other drawback of percutaneous fixation of thoracolumbar fractures is the requirement for future surgeries to remove the surgical implants. These revision surgeries may require significant muscle dissection.

Concluding, the available evidence shows that most of the patients with thoracolumbar fractures can be effectively managed with percutaneous instrumentation. They will likely benefit from less blood loss, a shorter operative time and long-lasting functional and radiological outcomes.

References

1. Leucht P, Fischer K, Muhr G, et al. Epidemiology of traumatic spine fractures. *Injury*. 2009;40(2):166–172.
2. Magerl F, Aebi M, Gertzbein SD, et al. A comprehensive classification of thoracic and lumbar injuries. *Eur Spine J*. 1994;3:184–201.
3. Verlaan JJ, Diekerhof CH, Buskens E, et al. Surgical treatment of traumatic fractures of the thoracic and lumbar spine: a systematic review of the literature on techniques, complications, and outcome. *Spine*. 2004;29:803–814.
4. Siebenga J, Leferink VJ, Segers MJ, et al. Treatment of traumatic thoracolumbar spine fractures: a multicenter prospective randomized study of operative versus non-surgical treatment. *Spine*. 2006;31:2881–2890.
5. Kim DY, Lee SH, Chung SK, et al. Comparison of multifidus muscle atrophy and trunk extension muscle strength: Percutaneous versus open pedicle screw fixation. *Spine*. 2005;30(1):123–129.
6. Court C, Vincent C. Percutaneous fixation of thoracolumbar fractures: Current concepts. *Orthop Traumatol Surg Res*. 2012;98(8):900–909.
7. Abt NB, De la Garza-Ramos R, Olorundare IO, et al. Thirty day postoperative outcomes following anterior lumbar interbody fusion using the National Surgical Quality Improvement Program database. *Clin Neurol Neurosurg*. 2016;143:126–131.
8. Lee JK, Jang JW, Kim TW, et al. Percutaneous short-segment pedicle screw placement without fusion in the treatment of thoracolumbar burst fractures: is it effective? Comparative study with open short-segment pedicle screw fixation with posterolateral fusion. *Acta Neurochir*. 2013;155(12):2305–2312.
9. Magerl FP. Injuries of the thoracic and lumbar spine. *Langenbecks Arch Chir*. 1980;352:428–433.
10. Magerl FP. Stabilization of the lower thoracic and lumbar spine with external-skeletal fixation. *Clin Orthop*. 1984;189:125–141.
11. Assaker R. Minimal access spinal technologies: state-of- the-art, indications, and techniques. *Joint Bone Spine*. 2004;71:459–469.
12. Lyu J, Chen K, Tang Z, et al. A comparison of three different surgical procedures in the treatment of type A thoracolumbar fractures: a randomized controlled trial. *Int Orthop*. 2016;40(6):1233–1238.
13. Wang H, Zhou Y, Li C, et al. Comparison of open versus percutaneous pedicle screw fixation using the sextant system in the treatment of traumatic thoracolumbar fractures. *Clin Spine Surg*. 2017;30(3):E239–E246.
14. Phan K, Rao PJ, Mobbs RJ. Percutaneous versus open pedicle screw fixation for treatment of thoracolumbar fractures: systematic review and meta-analysis of comparative studies. *Clin Neurol Neurosurg*. 2015;135:85–92.
15. Sun XY, Zhang XN, Hai Y. Percutaneous versus traditional and paraspinal posterior open approaches for treatment of thoracolumbar fractures without neurologic deficit: a meta-analysis. *Eur Spine J*. 2017;26(5):1418–1431.
16. Ulutaş M, Seçer M, Çelik SE. Minimally invasive mini open split-muscular percutaneous pedicle screw fixation of the thoracolumbar spine. *Orthop Rev*. 2015;7(1):5661.
17. Zairi F, Court C, Tropiano P, et al. Minimally invasive management of thoraco-lumbar fractures: combined percutaneous fixation and balloon kyphoplasty. *Orthop Traumatol Surg Res*. 2012;98:S105–S111.
18. Fitschen-Oestern S, Scheuerlein F, Weuster M, et al. Reduction and retention of thoracolumbar fractures by minimally invasive stabilisation versus open posterior instrumentation. *Injury*. 2015;46:S63–S70.
19. Pishnamaz M, Oikonomidis S, Knobe M, et al. Open versus percutaneous stabilization of thoracolumbar spine fractures: a short-term functional and radiological follow-up. *Acta Chir Orthop Traumatol Cech*. 2015;82:274–281.
20. Heintel TM, Berglehner A, Meffert R. Accuracy of percutaneous pedicle screws for thoracic and lumbar spine fractures: a prospective trial. *Eur Spine J*. 2013;22(3):495–502.
21. Park Y, Ha JW, Lee YT, et al. Percutaneous placement of pedicle screws in overweight and obese patients. *Spine J*. 2011;11(10):919–924.
22. Lehmann W, Ushmaev A, Ruecker A, et al. Comparison of open versus percutaneous pedicle screw insertion in a sheep model. *Eur Spine J*. 2008;17(6):857–863.

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23. Kumar A, Aujla R, Lee C. The management of thoracolumbar burst fractures: a prospective study between conservative management, traditional open spinal surgery and minimally interventional spinal surgery. *Springerplus*. 2015;4:204.

24. Hirano T, Hasegawa K, Takahashi HE, et al. Structural characteristics of the pedicle and its role in screw stability. *Spine*. 1997;22(21):2504–2509.

25. Fraser J, Gebhard H, Irie D, et al. Iso-C/3- dimensional neuronavigation versus conventional fluoroscopy for minimally invasive pedicle screw placement in lumbar fusion. *Minim Invasive Neurosurg*. 2010;53(4):184–190.

26. Cheung NK, Ferch RD, Ghahreman A, et al. Long-term Follow-up minimal access and open posterior lumbar interbody fusion for spondylolisthesis. *Neurosurgery*. 2013;72(3):443–450.

27. Court C, Vincent C. Percutaneous fixation of thoracolumbar fractures: current concepts. *Orthop Traumatol Surg Res*. 2012;98(8):900–909.

28. Tian NF, Wu YS, Zhang XL, et al. Fusion versus nonfusion for surgically treated thoracolumbar burst fractures: a meta-analysis. *PLoS One*. 2013;8(5):e63995.