Clinical Case Report

Medicine®

OPEN

Transforaminal endoscopy in lumbar burst fracture

A case report

Yuanyi Wang, PhD[a], Cong Ning, MD[a], Liyu Yao, PhD[a], Xiuying Huang, MD[a], Chengliang Zhao, MD[b,*], Bin Chen, PhD[b,*], Nan Zhang, PhD[a,*]

Abstract

Rationale: Lumbar burst fractures are frequent injury resulting from high-energy trauma, and the patients suffer from pain and the neurologic dysfunction. Although minimally invasive techniques have advanced rapidly, it was the first time to apply transforaminal endoscopic combined with percutaneous pedicle screw fixation to treatment of lumbar burst fractures.

Patient concerns: A 33-year-old man underwent Magerl type A3.1 burst fracture at L2 and compression fractures at L3 due to falling from a height with severe lower back pain, sensory loss, and atony of the right leg.

Diagnoses: Burst fracture at L2, compression fractures at L3.

Interventions: The patient was presented to 1-stage operation of percutaneous pedicle screw fixation at L1, L2, L3, and L4 instead of delayed posterior open surgery. At 1 week after injury, the 2-stage operation with a percutaneous transforaminal endoscopic was undertaken for decompression.

Outcomes: No matter the function of nerve and imaging findings, all got ideal recoveries in just 3 days after 2-stage operation. At the 3-month follow-up, there was no loss of sagittal plane alignment, and spinal cord compression was completely relieved. The patient regained near-full neurologic function postoperatively.

Lessons: A minimally invasive surgery (ie, transforaminal endoscopic combined with percutaneous pedicle screw fixation) for the treatment of Magerl type A3.1 burst fracture at lumbar was feasible. In addition, the key to the recovery of neurological function is the complete and effective decompression of spinal.

Abbreviations: APVBHr = ratios between both the anterior and the posterior vertebral body height, CT = computed tomography, LDH = lumbar spine disc herniation, MRI = magnetic resonance imaging, RKA = regional kyphosis angle, TESSYS = transforaminal endoscopic spine system, VAS = visual analog scale, WA = wedge angle, YESS = Yeung endoscopic spine system.

Keywords: lumbar, spinal burst fracture, transforaminal endoscopic

1. Introduction

Lumbar burst fractures are a common trauma, mainly resulting from traffic accident and falling from high places. The surgical management of lumbar burst fractures is a complex decision-making process, which the subtype of fracture, patient systemic conditions, and multiple comorbidities should be taken into consideration preoperatively, and still remains treatment challenges. The traditional open surgery is often limited to relatively complex indications and has several shortcomings such as postoperative pain, blood loss, and hospital stays.[1,2] Hence, minimally invasive surgical techniques advance rapidly and show safe and effective in the treatment of burst fractures.[3–5]

Percutaneous transforaminal endoscopy has been increasingly used in clinical applications during the past 20 years. In 1997, Yeung et al proposed the Yeung endoscopic spine system (YESS) as a minimally invasive transforamnial approach for the surgical management of lumbar spine disc herniation (LDH) and simple compression fractures.[6–8] In the early 2000, Hoogland et al[9] developed the transforaminal endoscopic spine system (TESSYS), which made it possible to remove a herniated disc using a lateral, transforaminal, endoscopic approach via the intervertebral foramen.

In 2014, we modified TESSYS for our own use and have applied it to treat over 1000 patients. Our technique substantially improves clinicians' operative vision and surgical efficacy outcomes, places more emphasis on exposure of the nerve root and the median part of spine canal, and offers a standardized procedure for complete decompression compared to the original TESSYS.

Here, we report on the use of our technique for the surgical management of a patient with Denis type B and Magerl type A3.1 burst fracture at L2, compression fractures at L3, left transverse process fractures at L1 and L3, left and right transverse process fractures at L2, spinous process fracture at L1, facet syndrome

Editor: Bernhard Schaller.

YW and CN contributed equally to this work.

The authors declared that they have no conflicts of interest.

[a] The First Hospital of Jilin University, Jilin, [b] The Hospital of Chengde Medical College, Hebei, China.

[*] Correspondence: Chengliang Zhao and Bin Chen, The Hospital of Chengde Medical College, No. 36 Nanyingzi St. Chengde, Hebei 067000, China (e-mails: bluesea@163.com; blusea_211314@163.com); Nan Zhang, The First Hospital of Jilin University, No. 71 Xinmin St. Changchun, Jilin 130021, China (e-mail: zn0972@163.com).

Copyright © 2017 the Author(s). Published by Wolters Kluwer Health, Inc. This is an open access article distributed under the Creative Commons Attribution-NoDerivatives License 4.0, which allows for redistribution, commercial and non-commercial, as long as it is passed along unchanged and in whole, with credit to the author.

Medicine (2017) 96:46(e8640)

Received: 13 July 2017 / Received in final form: 24 October 2017 / Accepted: 25 October 2017

http://dx.doi.org/10.1097/MD.0000000000008640

between the right facet joints at L1 and L2, partial loss of neurologic function, hematoma of the right kidney, lung contusion, and an injured calcaneus.

2. Case report

This study was approved by the Ethics Committee and institutional Review Board of the First Hospital of Jilin University.

A 33-year-old man with a history of acute traumatic injury presented to the emergency department of our hospital 6 hours after a fall from a height of approximately 10 meters with severe lower back pain, sensory loss, and atony of the right leg.

On physical examination, body temperature was 37.2°C, blood pressure was 134/73 mm Hg, heart rate was 72 beats per minute, respiratory rate was 21 breaths per minute, and oxygen saturation was 98 while the patient was breathing ambient air. The patient was conscious, but could not fully sit up or move his right leg. He had tenderness on percussion of the lumbar and right kidney region. On neurological examination, right lower limb muscle strength was 2/5, and the patient had superficial hypesthesia from the level of the inguen. Left lower limb muscle strength was 4/5, and no sensory abnormality was detected. The patient experienced a slight loss of feeling in the perineal region. No tendon reflex or central nervous system pathology was identified. The pain visual analog scale (VAS) scored 5 for the lower limbs and 10 for the waist. Routine blood test showed hemoglobin 105 g/L and hematocrit 32.6%. Routine urinalysis showed hematuria with an erythrocyte count of 640.

Computed tomography (CT) revealed a burst fracture of the L2 vertebral body, a bone fragment 7.4 mm in diameter that had breached the spinal canal (Fig. 1A), compression fractures of the L3 vertebrae, and damage to the cortices of the left transverse processes of the vertebrae at L1 and L3, and left and right transverse processes of the vertebra at L2 (Fig. 1C), the right interior facet and spinous process of the vertebra at L1, and the ipsilateral superior facet of the vertebra at L2 (Fig. 1D). The patient also had hematoma of the right kidney, a lung contusion that resulted in hydrothorax, and an injured calcaneus. Magnetic resonance imaging (MRI) demonstrated that the bone fragment from the fractured vertebral body had projected into the spinal canal, directly compressing the dura mater from the right side.

The patient was diagnosed with Denis type B and Magerl type A3.1 burst fracture at L2, compression fractures at L3, left transverse process fractures at L1 and L3, left and right transverse process fractures at L2, a spinous process fracture at L1, facet syndrome between the right facet joints at L1 and L2, kidney contusion, and a calcaneus fracture.

The patient scored 8 on the Thoraco-Lumbar Injury Classification and severity score due to the burst and compression fractures at L2 and L3, respectively, incomplete paralysis of the lower limb, and damage to the posterior longitudinal ligament complex. Therefore, surgical treatment, including restoration of sagittal plane alignment, internal stabilization, and decompression, was recommended.

Published literature recommends delayed posterior open surgery in patients with burst fractures in the thoraco-lumbar region and partial neurologic function.[10] However, as delaying surgical intervention would have made locating and removing the bone fragment challenging, and a conventional posterior open surgery results in substantial trauma, a percutaneous transforaminal endoscopic approach and percutaneous pedicle screw fixation were considered appropriate for the management of this patient. Percutaneous transforaminal endoscopy can be performed earlier (within 72 hours vs 2–3 weeks after injury) than open surgery, without severe surgical trauma, or the need for general anesthesia, which allows spinal cord function to be monitored during surgery. Percutaneous pedicle screw fixation achieves spine stabilization and deformity correction.[11,12] Early restoration of sagittal plane alignment was expected to result in automatic reduction of the bone fragment and realignment with its corresponding vertebral body. Failing this, removal of the bone fragment would be achieved using percutaneous transforaminal endoscopic corpectomy via a foraminal approach, instead of minimally invasive posterior keyhole corpectomy.[13]

The first operative session involved percutaneous transpedicular instrumentation of the vertebral bodies at L1, L2, L3, and L4 under local anesthesia, guided by C arm fluoroscopy in the perpendicular plane. Vertebroplasty wires were inserted percutaneously through the pedicles as described by Wiesner et al.[14] Once the tip of the wire was in the anteromedial portion of the vertebral body, the stylet of the wire was replaced by a guidewire. Skin incisions were made after insertion of the guidewire. The pedicle was drilled using a sheath-dilator complex inserted along the guidewire. A cannulated screw (size 60–45 mm) was inserted into the pedicle guided by C-arm fluoroscopy in the lateral plane. The guidewire was removed, and perpendicular and lateral plane imaging were performed. Rods were tightened to the screws and the height of the vertebral bodies at L2 and L3 were restored. Postoperatively, the patient's lower back pain was decreased; however, it was still particularly prominent in the horizontal position. Physical examination revealed reduced tenderness and percussion pain over the lumber region, right lower limb muscle strength was 3/5, and numbness was restricted to the right calf and heel. All feeling in the perineal region was restored. A CT scan confirmed that the height of the vertebral bodies at L2 and L3 were restored to normal levels. However, the fracture fragments in the spinal canal and partial neurologic deficit remained.

At 1 week after injury, a second operative session was undertaken, involving reconstruction of the patient's spinal canal using percutaneous transforaminal endoscopic corpectomy. The patient was positioned in the left lateral position, a line across the spinous processes was marked, the space between L1 and L2 was identified by C arm fluoroscopy, and the intersection point of the line and the space was confirmed. The entry point was 10 cm to the right of the intersection point and 2 cm horizontal to the cranial side. After skin preparation and draping, local anesthesia was induced using 8% lidocaine injected with a 22-gauge needle and syringe, directed into the subcutaneous tissue, fascia, and facet capsule. A 16-gauge needle was inserted percutaneously directly to the tip of the superior facet guided by C-arm fluoroscopy (Fig. 2). The puncture tract was dilated and foraminaplasty was performed using bone drills with diameters of 4, 6, 7, and 8 mm. A working cannula was inserted into the dilated tract through the foramen, and the distal end of the cannula was extended to the median part of the spinal canal until the cannula tip reached the posterior-superior end of the L2 vertebra, as visualized by C-arm fluoroscopy in the lateral plane (Fig. 2). The bone fragment that was constricting the dural sac, and the right nerve root was identified and resected using a piecemeal method; the dura and nerve root were decompressed. Total operating time was 2.5 hours, and blood loss was approximately 30 mL. Physical examination on postoperative day 1 revealed the patient had no lower back pain in the horizontal position, right lower limb muscle strength had

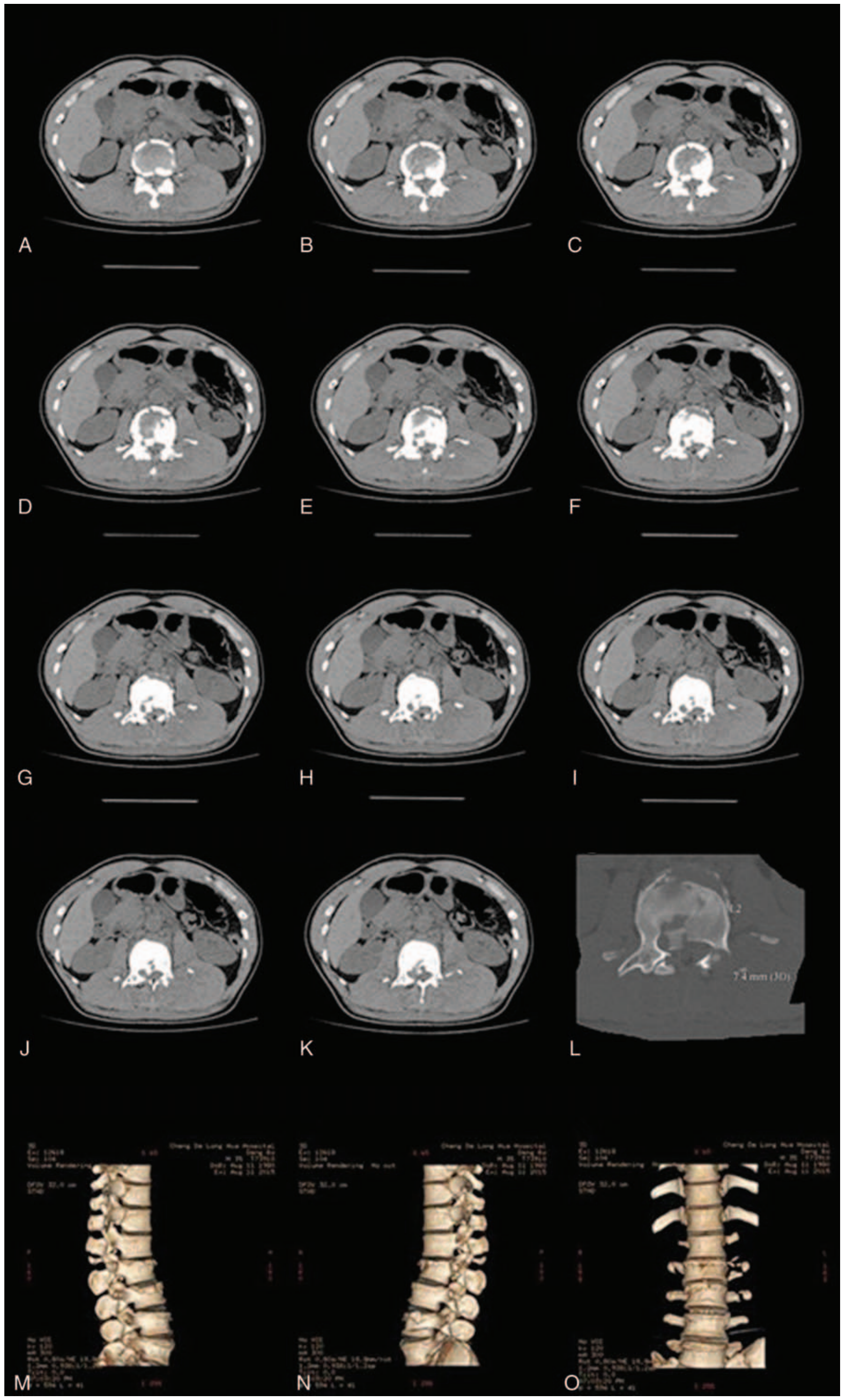

Figure 1. Computed tomography showing: Magerl type A3.1 burst fracture and facet disorder (A–K). A bone fragment 7.4 mm in diameter that had breached the spinal canal on the posterior edge of the vertebral body at L2. (L) Damage to the cortices of the left transverse processes of the vertebrae at L1 and L3, and left and right transverse processes of the vertebra at L2 (O). 3D computed tomography showing damage to the right interior facet and spinous process of the vertebra at L1 and the ipsilateral superior facet of the vertebra at L2 (M–O).

improved to 4/5, the patient reported no calf numbness or right lower limb pain, and the patient was able to walk at a slow gait for a short distance.

On postoperative day 3, MRI revealed that the bone fragments had been completely removed from the spinal canal. In addition, the continuous signal of cerebrospinal fluid in T2-weighted suggested the decompression on spinal dura mater (Fig. 3A) and a restoration of space in spinal canal (Fig. 3C). For further study on effect of operations, wedge angle (WA), regional kyphosis angle (RKA), and ratios between both the anterior and the posterior vertebral body height (APVBHr) were measured in CT as previous.[15,16] As seen in Fig. 3D and E, WA between the

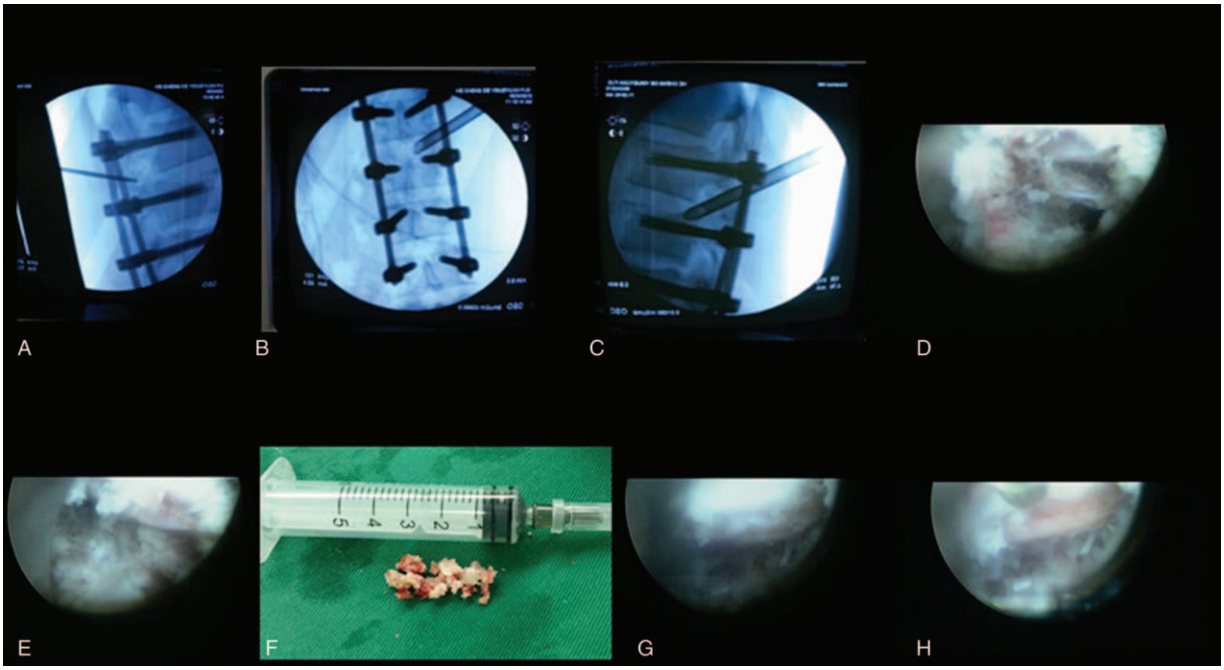

Figure 2. C-arm fluoroscopy monitored percutaneous transforaminal endoscopy. Tommy III needle was inserted percutaneously directly to the tip of the superior facet (A). After foraminaplasty, a working cannula was inserted into the foramen to the median part of the spinal canal until the cannula tip reached the posterior-superior end of the L2 vertebra (B, C). The bone fragment was identified and removed using percutaneous transforaminal endoscopy (D–F). When decompression was complete, the nerve root regained circulation (G, H).

superior and inferior endplate at L2 and L3 were preserved significantly from 5.9° to 2.0°, and from 2.5° to 1.0°, respectively. At the same time, significant increases (from 68.8% to 90.9%, and from 88.9% to 94.1%) were maintained at L2 and L3 compared with preoperative APVBHr, which demonstrated the restoration of fracture vertebral. RKA of burst fracture decreasing indicated the sagittal stability in region. In axial view of spinal canal, 33.4% region was liberated absolutely (Fig. 3F and G). MRI and CT scans revealed that vertebral body height obtained restoration and spinal cord compression was completely relieved.

On postoperative day 14, the patient received surgery on his calcaneus. The patient was followed for 3 months after discharge. At the 3-month follow-up, radiological examination revealed no broken screws or nails and no loss of sagittal plane alignment. The patient had a significant improvement in neurological

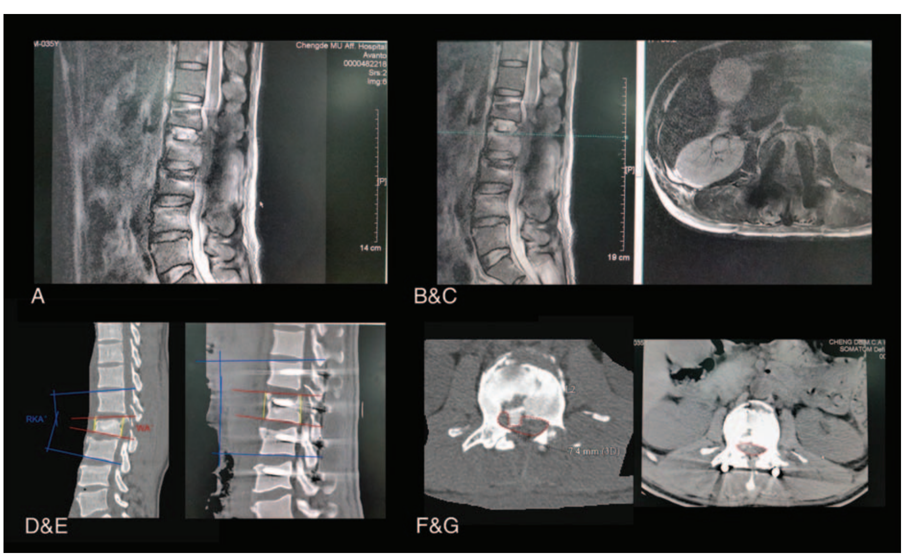

Figure 3. Postoperative magnetic resonance imaging (A–C) showing the bone fragments had been completely removed from the spinal canal. Computed tomography of preoperation (D, F) and postoperation (E, G). WA: angle between the superior and inferior endplate of the fractured vertebra; RKA: angle between the tangent of the superior endplate of the cephalad vertebra of the fracture and the tangent of the inferior endplate of the caudal vertebra (D, E). The spinal canal was indicated by dotted lines (F, G).

function. Most of the patient's sensory and locomotor function was regained, and he suffered no low back pain. The VAS scale of lower limbs and waist both decreased to 0.

3. Discussion

To our knowledge, this is the first report of a percutaneous transforaminal endoscopic approach combined with percutaneous pedicle screw fixation for the correction of altered sagittal plane alignment and a burst fracture. Percutaneous transforaminal endoscopy and percutaneous pedicle screw fixation are minimally invasive techniques that are associated with reduced operative time, cutting and detachment of fewer muscles, less blood loss, no need for general anesthetic, less postoperative pain, and an earlier recovery compared to conventional posterior open surgery.[2,17] Published literature indicates that percutaneous pedicle screw fixation is appropriate for the management of thoraco-lumbar Magerl type A3 fractures[18]; however, the fixation of type A3 fractures with neurological injury remains a controversial issue. If relocation fails, percutaneous fixation alone cannot offer effective spinal canal clearance and nerve decompression. We solved this dilemma using percutaneous transforaminal endoscopy.

Percutaneous transforaminal endoscopy is widely applied in lumbar surgery, including the management of lumbar stenosis[19] and cervical spondylosis.[20] In this case, the patient was suffering from pain and incomplete paralysis caused by a burst fracture at L2. There are no published reports of the use of percutaneous transforaminal endoscopic techniques for management of such trauma. L2 marks the end of the spinal cord and the beginning of the cauda equine. This suggests our approach is a potential option for decompression of all other lumbar segments, including L1.

Percutaneous transforaminal endoscopy and percutaneous fixation have gained popularity in the past few years. In China, due to the influence of traditional Chinese medicine and economic issues, conservative treatments appeal to patients more than radical approaches. To accommodate patients' preferences, Chinese clinicians have mastered minimally invasive techniques. The current case study suggests that percutaneous transforaminal endoscopy can be used to remove burst fracture fragments from the spinal canal, and the combination of percutaneous transforaminal endoscopy and percutaneous fixation may lead management of lumbar burst fracture in the minimally invasive era. In view of previous experience in percutaneous transforaminal endoscopy and the successful combination with percutaneous pedicle screw fixation, several tips were summarized as follows to apply 2 kinds of surgery more effectively, especially for endoscopy technology.

1. Lumbar burst fractures are often accompanied by sagittal deviation of the vertebral body, and the mechanical and anatomical structures of the spine should be restored firstly by percutaneous fixation. Then the percutaneous transforaminal endoscopy should be performed if compression on the spinal dura mater was still not moderated.
2. The percutaneous transforaminal endoscopy is suitable for lumbar burst fractures which tremendous compression exists in canal (ie, the transverse and sagittal diameter of compression mass are not greater than 15 and 10 mm, respectively, and the compression area is not greater than 50% in radiological evaluation) without vertebral dislocation.
3. The removal of small and broken bone fragment in the ipsilateral and contralateral spinal canal should be notable.
4. Lumbar burst fractures with spinal dislocation and complete spinal cord injury are contraindications to these operations.

The use of percutaneous transforaminal endoscopy in burst fracture surgery is associated with several limitations.

1. Not all regions of the spinal cord are accessible with percutaneous transforaminal endoscopic techniques; therefore, decompression may be inadequate in some cases.
2. Trials of percutaneous transforaminal endoscopic techniques address unilateral fractures, although our technique indicates decompression of the contralateral canal during surgical management of LDH surgery can be achieved. However, contralateral decompression during surgical management of burst fracture requires further investigation.
3. A spinal canal radiogram should be considered routine before surgery with percutaneous transforaminal endoscopic techniques in patients with burst fracture to evaluate the integrity of the dural sac. In the current case, leakage of cerebrospinal fluid was excluded by a MRI scan.

4. Conclusions

In conclusion, a minimally invasive surgery (ie, transforaminal endoscopic combined with percutaneous pedicle screw fixation) for the treatment of Magerl type A3.1 lumbar fracture with neurological injury was feasible. Postoperative recovery of neurological function is mainly determined by the sagittal alignment restore, effective spinal canal clearance, and nerve decompression. In addition, percutaneous transforaminal endoscopic techniques, which were applied to the lumbar burst fractures by our team firstly, could be a useful alternative to the classic open surgery approaches.

References

[1] Li X, Zhang J, Tang H, et al. Comparison between posterior short-segment instrumentation combined with lateral-approach interbody fusion and traditional wide-open anterior-posterior surgery for the treatment of thoracolumbar fractures. Medicine 2015;94:44.
[2] Park Y, Ha JW. Comparison of one-level posterior lumbar interbody fusion performed with a minimally invasive approach or a traditional open approach. Spine 2007;32:537–43.
[3] Kalra RRS, Schmidt MH. The role of a miniopen thoracoscopic-assisted approach in the management of burst fractures involving the thoracolumbar junction. Neurosurg Clin N Am 2017;28:139–45.
[4] Cui S, Busel GA, Puryear AS. Temporary percutaneous pedicle screw stabilization without fusion of adolescent thoracolumbar spine fractures. J Pediatr Orthop 2016;36:701–8.
[5] Li K, Zhang W, Liu D, et al. Pedicle screw fixation combined with intermediate screw at the fracture level for treatment of thoracolumbar fractures: a meta-analysis. Medicine 2016;95.:33.
[6] Kambin P, Zhou L. Arthroscopic discectomy of the lumbar spine. Clin Orthop Relat Res 1997;337:49–57.
[7] Ditsworth DA. Endoscopic transforaminal lumbar discectomy and reconfiguration: a postero-lateral approach into the spinal canal. Surg Neurol 1998;49:588–97. [discussion 597-588].
[8] Yeung AT, Tsou PM. Posterolateral endoscopic excision for lumbar disc herniation: surgical technique, outcome, and complications in 307 consecutive cases. Spine 2002;27:722–31.
[9] Hoogland T, Schubert M, Miklitz B, et al. Transforaminal posterolateral endoscopic discectomy with or without the combination of a low-dose chymopapain: a prospective randomized study in 280 consecutive cases. Spine 2006;31:E890–897.
[10] Yazici M, Gulman B, Sen S, et al. Sagittal contour restoration and canal clearance in burst fractures of the thoracolumbar junction (T12-L1): the efficacy of timing of the surgery. J Orthop Trauma 1995;9:491–8.

[11] Giorgi H, Blondel B, Adetchessi T, et al. Early percutaneous fixation of spinal thoracolumbar fractures in polytrauma patients. Orthop Traumatol Surg Res 2014;100:449–54.
[12] Scaramuzzo L, Tamburrelli FC, Piervincenzi E, et al. Percutaneous pedicle screw fixation in polytrauma patients. Eur Spine J 2013;22(suppl 6):S933–938.
[13] Maciejczak A, Barnas P, Dudziak P, et al. Posterior keyhole corpectomy with percutaneous pedicle screw stabilization in the surgical management of lumbar burst fractures. Neurosurgery 2007;60(4 suppl 2):232–41. [discussion 241-232].
[14] Wiesner L, Kothe R, Ruther W. Anatomic evaluation of two different techniques for the percutaneous insertion of pedicle screws in the lumbar spine. Spine 1999;24:1599–603.
[15] Kitzen J, Schotanus MGM, Plasschaert HSW, et al. Treatment of thoracic or lumbar burst fractures with balloon assisted endplate reduction using tricalcium phosphate cement: histological and radiological evaluation. BMC Musculoskelet Disord 2017;18:411.
[16] Mayer M, Ortmaier R, Koller H, et al. Impact of sagittal balance on clinical outcomes in surgically treated T12 and L1 burst fractures: analysis of long-term outcomes after posterior-only and combined posteroanterior treatment. BioMed Res Int 2017;2017:1568258.
[17] Khoo LT, Palmer S, Laich DT, et al. Minimally invasive percutaneous posterior lumbar interbody fusion. Neurosurgery 2002;51(5 suppl): S166–181.
[18] Proietti L, Scaramuzzo L, Schiro GR, et al. Posterior percutaneous reduction and fixation of thoraco-lumbar burst fractures. Orthop Traumatol Surg Res 2014;100:455–60.
[19] Wu B, Zhang S, Lian Q, et al. Lumbar scoliosis combined lumbar spinal stenosis and herniation diagnosed patient was treated with “U” route transforaminal percutaneous endoscopic lumbar discectomy. Case Rep Orthop 2017;2017:7439016.
[20] Ohmori K, Ono K, Hori T. Outcomes of full-endoscopic posterior cervical foraminotomy for cervical radiculopathy caused by bony stenosis of the intervertebral foramen. Mini-invasive Surg 2017;1:63–8.