Thoracoscopic Anterior Reconstruction Combined with Posterior Pedicle Screw-Based Fixation in Management of Thoracolumbar Junction Fractures

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Abstract

Background: Video-assisted thoracoscopic surgery is a minimally invasive procedure applied to the field of spine surgery since 1990s.

Purpose: To explore the feasibility, safety, efficacy, and cosmetic results of thoracoscopy in management of thoracolumbar fractures.

Methods: We used both the Thoracolumbar Injury Classification and Severity (TLICS) score and the Load Sharing Classification Score for selection of cases. Cases were operated on by a combined approach of posterior pedicle screw fixation and anterior thoracoscopic reconstruction and fusion with follow up of cases up to 12 months as regard clinical and radiological results.

Results: Patients' ages ranged from 22-56 years, including 8 males and 7 females. Falls were the most common cause and LV1 was the most common level. Two cases were reconstructed by a corpectomy cage, while the rest by tricortical iliac bone graft. All except two cases showed signs of fusion at 12 months, while all cases were cosmetically satisfied. Neither major complications nor death were reported.

Conclusion: Video-assisted thoracoscopic reconstruction of thoracolumbar fractures is an effective, minimally invasive, relatively safe technique that needs further training to widen its applications.

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Key Words: Thoracolumbar, fracture, posterior fixation, anterior approach, thoracoscopy.

Introduction

Each year, there are approximately 5 million new vertebral fractures worldwide.[24] The thoracolumbar junction, being the mechanical transition zone between the rigid thoracic and the flexible lumbar spine, is the most common site of injury.[11] However, the diagnosis of thoracolumbar fracture cannot be ruled out in the presence of normal neurological examination, as the majority of these injuries do not have associated neurological deficits.[15]

The proper way of management for thoracolumbar fractures is still a matter of debate. The debate includes; conservative versus surgical, anterior versus posterior, early versus delayed…etc. One of the recent debates around management of thoracolumbar fractures is whether to treat it using the recent modifications of the old conventional methods like the recently described mini-open techniques,[8, 14, 18, 25] versus the use of the minimally invasive technology of video-assisted thoracoscopic surgery (VATS) that was introduced in the nineties of the last century.[21, 22]

Although many studies had reported the efficacy and safety of video-assisted thoracoscopic spine surgery, [1, 3-5, 7, 13, 17, 20] such technique is still in its infancy in our locality. It is a virgin field that is not sufficiently explored by local spine surgeons to discover its potential applications. In this study, we are trying to explore the feasibility, safety, and efficacy of this technique in management of thoracolumbar burst fractures that need anterior reconstruction.

Patients and Methods

This is a prospective study carried on in a busy trauma center by a team of orthopedic and neurological surgeons. The study was conducted between June 2009 and July 2011, including 15 cases of thoracolumbar burst fractures admitted to ElHadara University Hospital. The selection of cases for surgery was based on the Thoracolumbar Injury Classification and Severity (TLICS) Score [29], and the candidacy for anterior reconstruction was based on the Load Sharing Score. [23] All selected cases were TLICS ≥ 4, and have Load Sharing score ≥ 7. Moreover, cases with extremes of age, medical problems that preclude general anesthesia, severe psychiatric illness, or more than one level of fracture were excluded from our study. Selection criteria for eligibility are listed in (table 1).

Table 1. Selection criteria for trial eligibility.

Inclusion	Exclusion
• Age 18–60 years. • Proved (radiologically) fracture in the thoracolumbar area from T10-L2. • TLICS Score ≥4. • Load Sharing Score ≥7.	• Medical co-morbidities making surgery hazardous. • Pleural adhesion and/ or history of previous thoracotomy. • More than one level fractured. • Pregnancy. • Severe psychiatric illness.

Preoperative evaluation:

Patients who entered the study, underwent careful history taking that provides important insights into the pathomechanics of the injury, thus determining which force vectors predominates (whether force was in the direction of axial load, flexion, or rotational). Careful neurological examination was conducted and its results were reported. The American Spinal Injury Association (ASIA) Impairment Scale was used in documenting, monitoring, and treating neurologic injuries.[2]

Initial radiographic assessment includes anteroposterior (AP) and lateral spine films, assessed for loss of vertical body height, malalignment of vertebral bodies, widening of interspinous distance. Computerized tomography (CT) was used to reveal the degree of canal compromise, degree of separation of bone fragments, and pedicular diameter for screw diameter selection. Magnetic resonance imaging (MRI) was used in evaluating those patients with neurologic injury that cannot be accounted for by osseous disruption on plain radiographs and a CT scan.

Preoperative laboratory investigations included, routine full investigations (CBC, INR, Blood grouping, LFTs, Serum creatinine, RBS, ECG), in addition to chest x-ray and pulmonary function tests for those who undergo VATS approach.

Equipments

All equipments used were provided by KARL STORZ®, Germany, including 10 mm portals, 36 cm long rigid 45º angled telescope, telecam-C with adjustable focus, light source with xenon lamp, Sony® video monitor, and instruments especially designed for endoscopy.

Surgical technique

Cases were operated in the prone position under general anesthesia using single lumen endotracheal tube permitting double lung ventilation. All cases underwent posterior pedicle-screw based fixation first, then anterior thoracoscopic reconstruction was conducted in the same position using tricortical iliac bone graft or cage insertion. Finally, the screws became attached and tightened to the rods in some compression.

Draping was done so that the surgeon can access the midline back at the desired level, the posterior iliac crest, and the left side of the chest laterally and anterior to the anterior axillary line (Figure. 1a). A 3 cm incision for the working port was positioned directly over the target vertebra parallel to the ribs and centered over the mid-axillary line directed by fluoroscopy. Scope port were marked two or three intercostal spaces above the working port in the posterior axillary line (figure. 1b). We first started by the 1 cm scope port incision through which the 45º angled endoscope could be introduced. This was followed by opening of the 3 cm working port incision under direct vision through the endoscope. This 3 cm incision was used as a working port for diaphragmatic retraction, irrigation, suction, and passage of the working instruments. We did not need more than these two incisions.

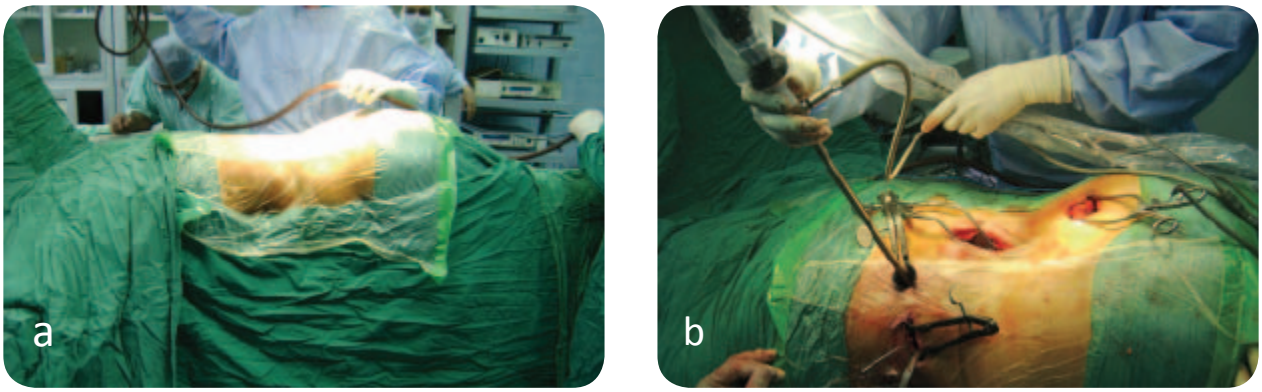
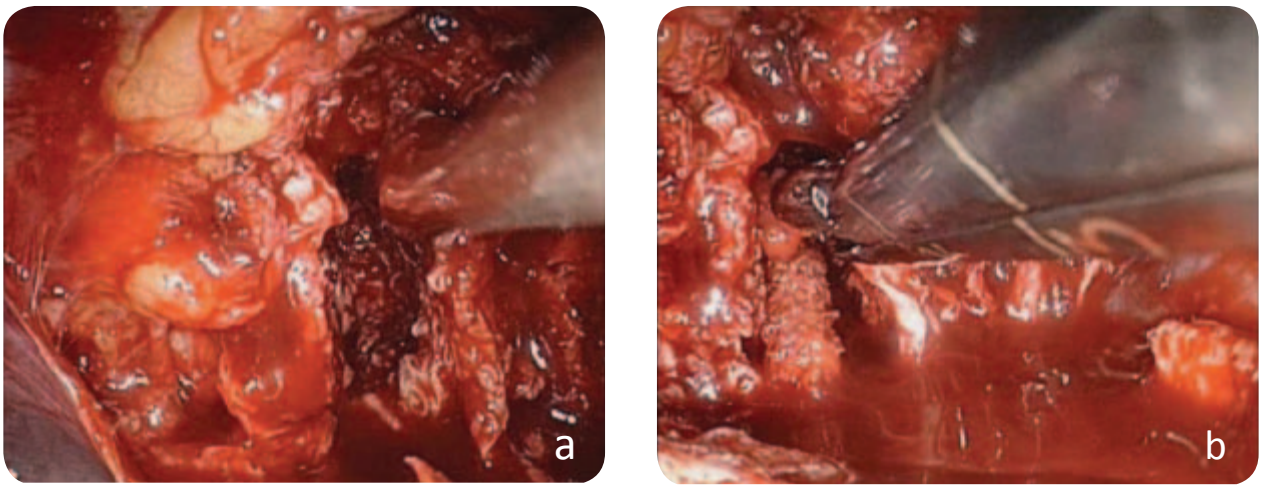


Figure 1. (a) patient position and draping, (b) incisions and ports

Using a broad spatula for diaphragmatic retraction, operating in the prone position, and reducing the tidal volume of ventilation, exploration of the thoracic cavity was easier while permitting double lung ventilation. The diaphragm usually inserts at the TV12-LV1 level perpendicular to the spine. The diaphragm was opened endoscopically if surgical exposure below the insertion of the diaphragm was needed. For exposure of LV1 and LV2, the diaphragm was opened farther caudally for up to 5 cm at its attachment site. The incision runs parallel to and 1 to 2 cm away from the diaphragmatic insertion. This remaining diaphragmatic strip was used to close the diaphragm. This technique obviated the need for complete detachment of the diaphragmatic insertion, as required in open procedures. After the diaphragm had been split, the retroperitoneal fat and peritoneal sac were bluntly dissected away from the fascia of the psoas muscle to expose the vertebral bodies.

Once the desired segment of the spine was identified, the parietal pleura over the spine was opened using a pointed dissector and the opening was extended over the whole desired segment of the spine. At this point, the vertebral body surface with the above and below intervertebral discs and the segmental blood vessels became clear. Discectomy in the conventional method is undertaken using a scalpel for annulotomy, fenestrated punch forceps, and curette. When discectomy and removal of the cartilaginous end plates are completed (figure 2a), intersomatic bone graft placement is started. Discectomy was done in all cases with partial corpectomy reserved for those cases with significant retropulsed segments encroaching on the canal. The tricortical iliac bone construct was inserted in the desired disc space (figure 2b) aided by distraction of the motion segment using the posteriorly placed screws, or by gentle palmar pressure on the back of the patient to minimize the local kyphosis and open the anterior disc space. The placed bone construct was then tapped using a blunt-tipped instrument and a hummer. Reconstruction and fusion was accomplished in some patients using a titanium cage filled with cancellous bone inserted in the defect (figure 2c).



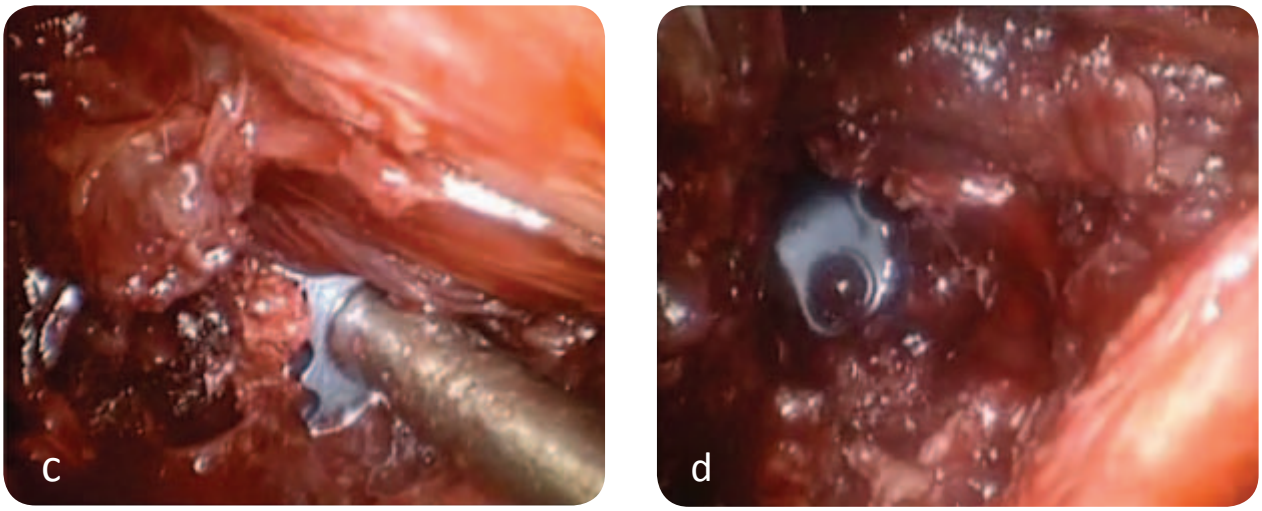


Figure 2. Thoracoscopic views. (a) completed discectomy, (b) insertion of interbody iliac bone graft for fusion, (c) insertion of interbody cage, (d) view at the conclusion of procedure before closure with cage in-situ.

At the end of procedure, the diaphragmatic split was closed when possible to avoid diaphragmatic hernia, the chest cavity was inspected for any bleeding points, and a chest tube was inserted through the working port under direct vision of the endoscope. The incisions were closed, and extubation was usually done immediately after the procedure. Follow up X-rays were done to verify normal lung expansion. The chest tube was not usually removed until air leakage ceases or until drainage became less than 150 ml per 24 hours.

Postoperative assessment

(A)Clinical assessment:

[a]Neurological improvement: determined by measuring the change in ASIA impairment scores 12 months postoperative.

[b]Cosmesis: evaluated by the patient and an independent surgeon using a Visual Analogue Scale ranging from 0 (very poor), to 10 (excellent) and the scores are calculated and their mean is obtained.

(B)Radiographic Assessment:

Radiological signs for fusion [end-point at 12 months postoperatively] were tested by an independent radiologist. Fusion is defined as contiguous bone from endplate to endplate without evidence of radiolucency along either margin and/or less than 5 degrees change in the Cobb angle on flexion/extension dynamic study.

Results

This is a prospective study that included 15 cases with thoracolumbar fractures that were in need for anterior reconstruction in addition to the posterior pedicle-screw based stabilization. The age of patients ranged from 22-56 years with a mean age of 31.06 years and a standard deviation of 9.28. Males were 8 (53.3%), and females were 7 (46.7%).

Eight of our patients (53.3 %) were victims of fall from height, constituting the most common mode of trauma. The second most common cause was motor vehicle accidents which affected 7 patients (46.7 %). Seven cases of fracture were at LV1 level (46.7 %), 4 cases at LV2 (26.7 %), 2 at TV12 (13.3 %), 1 at TV11 (6.7 %), and 1 case of TV10 fracture (6.7 %). According to the AO classification, all types of fractures in our study were burst fractures (type A), except 2 cases of rotational injury (type C), but no distraction injury (type B).

All cases entered our study were surgical candidates according to the Thoracolumbar Injury Classification and Severity Score (TLICS). This means that all patients included had at least TLICS Score of 5 or a score of 4 with preference of surgery over conservative treatment. Only two cases with score 4 were included, while the rest were ≥ 5. All cases in our study were in need for anterior reconstruction (score ≥ 7 according to the Load Sharing Classification). The mean score of patients was 7.2.

The vast majority of cases (N=12 cases, 80%) underwent reconstruction using an intersomatic tricortical iliac bone graft placement combined with posterior transpedicular screws and rods fixation. Only 3 cases (20%) underwent reconstruction using an intersomatic, or corpectomy cage placement combined with the posterior screws and rods

fixation. The timing of surgery varied from the 2nd, to the 7th posttraumatic day. Five cases in our study were operated on their 2nd posttraumatic day, while 2 cases were delayed up to the 7th day. The mean timing for reconstruction was 3.4 ± 1.5 days. The mean length of procedures was 5.3 ± 1.2 hours. However, when earliest and latest 3 procedures were compared there was a significant difference in length of procedures (mean of 6.2 versus 3.6 hours, respectively). The blood loss was lesser in late (200-350 ml in the last 5 cases) than early cases (750-1300 ml in the first 5 cases). The mean blood loss was 652 ± 130 ml. Intraoperative complications were nil.

When ASIA scores were compared at 12 months postoperatively with those initial scores (table 2), we found those with score A or E remained unchanged till end of the study, while those with scores B, C, and D improved on the scale to higher scores with time. As regard cosmosis, the lowest patient VAS score for cosmosis was 7 (1 case) and the highest was 10 (1 case), while lowest physician VAS score was 7 (3 cases) and the highest was 9 (7 cases). The mean cosmosis score on the VAS (mean of patients' and physicians' scores) was 8.4 ± 0.4 (figure 3).

Table 2. ASIA scores of the study group, initially and at 12 months.

	Initial ASIA score	ASIA score at 12 months
A	*3(20.0%)*	*3(20.0%)*
B	*1(6.7%)*	*0(0.0%)*
C	*3(20.0%)*	*2(13.3%)*
D	*5(33.3%)*	*4(26.7%)*
E	*3 (20.0%)*	*6(40.0%)*

Radiological follow up of cases was directed to evaluate fusion at 12 months. At the end of the 12 month-follow up period, 2 cases were found with no radiological signs of fusion. These 2 cases with failed fusion included the 4th, and the 6th cases which were early cases in our study, while the other 13 cases showed radiological signs of fusion (figure 4, 5) at the end of the 12 months. The rate of fusion is 87%. Canal clearance was achieved in most cases, however, it was not an aim of our study as any intracanalicular residual will be disappear after fusion by remodeling process. The postoperative hospital stay ranged from 4 to 8 days. The mean hospital stay was 5.9 ± 0.8 days.

Figure 3. A case with thoracolumbar fracture who underwent posterior stabilization using short segment pedicle screw-rod system (midline vertical wound), combined with thoracoscopic reconstruction of anterior column in the same setting (Left inclined wound). Note the good cosmosis of the wound used for thoracoscopy.

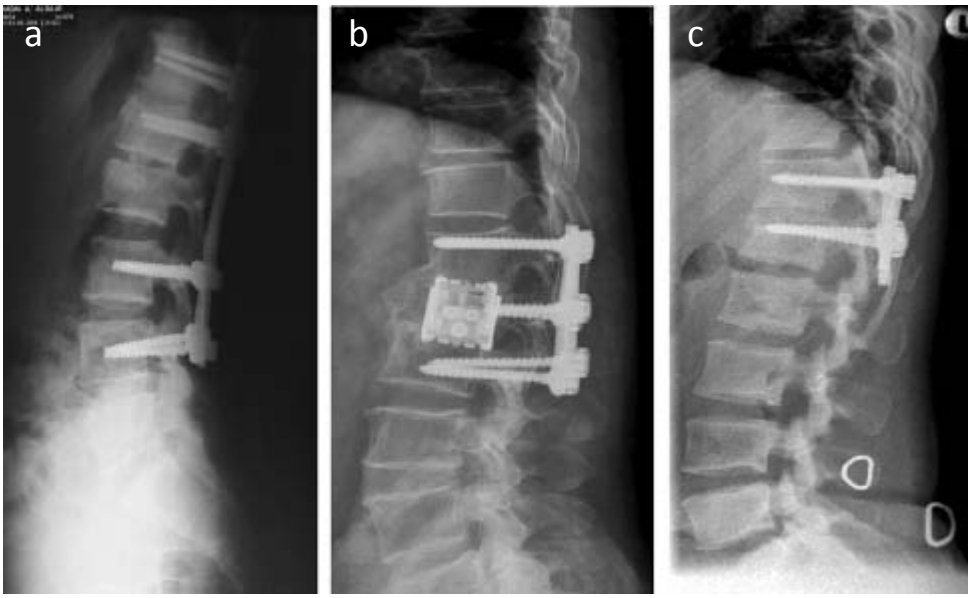


Figure 4. Radiographs of three cases of thoracolumbar fractures constructed thoracoscopically. (a), and (c) were reconstructed using harvested iliac bone graft. (b) was reconstructed using expandable corpectomy cage filled with cancellous bone.

Figure 5. showing LV2 burst fracture with retro-plused fragment and severe canal compromise associated with LV1 fracture without retro-plusion. as depicted on preoperative images a; sagittal MRI, b; axial CT bone window, c; sagittal reconstruction CT. d, e images; 1 month follow-up after LV3 corpectomy and iliac crest grafting with long segment fixation. F; 6 months follow-up showing good alignment and good take of the graft.

Discussion

With the improvements in access technology, interest in approaching the thoracolumbar junction with the aid of the endoscope and surgical microscope has evolved. Therefore, various anterolateral transthoracic and transabdominal approaches with mini-open modifications has been developed as an attempt to achieve the same efficacy and minimize the drawbacks of the invasiveness of traditional approaches. [8, 14, 18] In parallel to these advances towards less invasion in open approaches, there were trials and progresses in the endoscopic access to the thoracic and thoracolumbar area. [3-5, 7, 17, 21, 22]

Those who advocate video-assisted endoscopic spine surgery are still reporting feasibility and safety of the technique, with better cosmoses, less blood loss, less postoperative discomfort, shorter hospital stay, and in good hands; equivalent outcomes to open procedures. [1, 13, 22] Few spine surgeons have enough experience to conduct studies for exploring the efficacy and safety of such technique.

The mean age of patients in our study was 31.06 years and it ranged from 22 to 56 years. This age correlates with most series dealing with vertebral fractures where mean ages lie in the first half of thirties. [9, 19, 21] The most common age group is that of late third and early fourth decades, as this age is the age of maximum activity in the community and practicing risky jobs and dangerous styles of driving. The male predominance in our study agrees with the literature. However, male-to-female ratio in our study differs from other studies. It is far different from some epidemiological studies, [6, 27] where in the rural setup, the ratio of male to female ranges from 9:1 to 13.5:1. Another study done by Upendra et al, 28 reported a male-to-female ratio of 4.5:1. 30 Many studies, [9, 19] reported that men are 2-4 times more likely to have these fractures compared to women. Although our sample of study is too small to explain the difference, it seems that community economic and traditional characteristics are responsible for the distribution of vertebral fractures among both sexes.

Fall from height was the most common mode of injury in our study. This agrees with several studies [6, 27, 28] and contradicts others studies that reported motor vehicle accidents to be the most common. [12, 26] This discrepancy may be due to the lack of safety measures for those who work at heights in our society. We found LV1 vertebral level to be the most commonly affected which agree with the literature. However, LV2 level was found to be the second common, which disagree with other studies that found TV12 to be the second common vertebral level in thoracolumbar fractures. We explain this by the fact that those studies defined thoracolumbar fracture as being from TV11-LV1.

Performance of thoracolumbar reconstruction in the prone position enabled us to simultaneously access the spine from its ventral and dorsal aspects. The prone position gives us an access to fix the spine by pedicle screws, harvest a tricortical iliac graft, and in the same position we can access the spine thoracoscopically for anterior reconstruction. Moreover, the prone position helps to bring the lung away from the spine by gravity, and can help to reduce kyphosis and open the disc space anteriorly by gentle pressure applied to the back.

Although it has been reported that up to 3-8% of patients with complete spinal cord injury can reach an ambulatory status, 10 we found no improvement among those patients with ASIA score A during the period of follow up. This is due to the usual delay of referral or the inexperienced transport of such patients which results in irreversible secondary insult of the cord. However, the majority of those with partial cord injury improved and those with intact neurological status remained intact. All patients were satisfied with wound shape and length with reported excellent cosmetic results. As regard fusion, we fulfilled about 87% fusion rate which correlates well with the results of others. [16]

Conclusion

Thoracoscopy was found to be an effective limited procedures in achieving spinal fusion with the extra benefit of minimal invasion, better cosmetic results, one-staged operation, and relatively shorter postoperative hospital stay. Further training and enthusiastic research can open wider field for application of thoracoscopy in the future.

References

1) Al-Sayyad MJ, Crawford AH, Wolf RK. Video-assisted thoracoscopic surgery: The Cincinnati experience. Clin Orth and Related Research 434:61-70, 2005.
2) American Spinal Cord Injury Association, Standards for neurological and functional classification of spinal cord injury, revised. Chicago, IL: American Spinal Cord Injury Association; 1992.

3) Anand N, Regan JJ: Video-assisted thoracoscopic surgery for thoracic disc disease: Classification and outcome study of 100 consecutive cases with a 2-year minimum follow-up period. Spine 27:871–9, 2002.
4) Bergey DL, Villavicencio AT, Goldstein T, et al. Endoscopic lateral transpsoas approach to the lumbar spine. Spine 29:1681–8, 2004.
5) Böhm H, Elsaghir H: Dorsale Stabilisierungen, in Reichel H, Zwipp H, Hein W (eds): Wirbelsäulenchirurgie: Standortbestimmung und Trends. Darmstadt, Steinkopff, 2000, pp 102–5.
6) Chacko V, Joseph B, Mohanty SP, Jacob T. Management of spinal cord injury in a general hospital in rural India. Paraplegia 24:330–5, 1986.
7) Elsaghir H. Endoscopic medial parascapular approach to the thoracic spine. Surg Endosc 19:389–92, 2005.
8) ElSaghir H. Extracoelomic mini approach for anterior reconstructive surgery of the thoracolumbar area. Neurosurgery 51(2):118-22, 2002.
9) Erturer E, Tezer M, Ozturk I. Evaluation of vertebral fractures and associated injuries in adults. Acta Orthop Traumatol Turc 39(5):387-90, 2005.
10) Fehlings MG, Sekhon LH. Cellular, ionic and biomolecular mechanisms of the injury process. In: Tator CH, Benzel EC, editors. Contemporary Management of Spinal Cord injury: From Impact to Rehabilitation. New York: American Association of Neurological Surgeons; 2000. pp. s33–50.
11) Flanders AE. Thoracolumber trauma imaging overview. Instructional course lectures 1999;48:429-31.
12) Gertzbein SD, Court-Brown CM. Flexion-distraction injuries of the lumbar spine. Mechanisms of injury and classification. Clin Orthop Relat Res 227:52-60, 1988.
13) Han PP, Kenny K, Dickman CA. Thoracoscopic approaches to the thoracic spine: Experience with 241 surgical procedures. Neurosurgery 51(2):88-95, 2002.
14) Huang TJ, Hsu RW, Li YY, et al. Minimal access spinal surgery (MASS) in treating thoracic spine metastasis. Spine 31:1860–3, 2006.
15) Hu R, Mustard CA, Burns C. Epidemiology of incident spinal fracture in a complete population. Spine 21:492-9, 1996.
16) Kaneda K, Taneichi H, Abumi K, et al. Anterior decompression and stabilization with the Kaneda device for thoracolumbar burst fractures associated with neurological deficits. *J Bone Joint Surg (Am*) 79(1):69-83, 1997.
17) Khoo LT, Beisse R, Potulski M: Thoracoscopic-assisted treatment of thoracic and lumbar fractures: a series of 371 consecutive cases. Neurosurgery 51(5 S):S104–S117, 2002.
18) Kim DH, Jaikumar S, Kam AC. Minimally invasive spine instrumentation. Neurosurgery 51(5 S):S15–S25, 2002.
19) Krompinger WJ, Fredrickson BE, Mino DE, et al. Conservative treatment of fractures of the thoracic and lumbar spine. Orthop Clin North (Am 17:161-70, 1986.
20) Liu GK, Kit WH. Video assisted thoracoscopic surgery for spinal conditions. Neurology India 53:489-98, 2005.
21) Mack MJ, Regan JJ, Bobechko WP, et al. Application of thoracoscopy for diseases of the spine. Ann Thorac Surg 56: 736–8, 1993.
22) McAfee PC, Regan JR, Zdeblick T, et al. The incidence of complications in endoscopic anterior thoracolumbar spinal reconstructive surgery. A prospective multicenter study comprising the first 100 consecutive cases. Spine 20:1624–32, 1995.
23) McCormack T, Karaikovic E, Gaines RW. The load-sharing classification of spine fractures. Spine 19:1741-4, 1994.
24) Melton LJ 3rd, Thamer M, Ray NF, et al. Fractures attributable to osteoporosis: Report from the National Osteoporosis Foundation. J Bone Miner Res 12:16-23, 1997.
25) Moskovich R, Benson D, Zhang ZH, et al. Extracoelomic approach to the spine. **J** Bone Joint Surg (Br) 75B:886-93, 1993.
26) Mumford J, Weistein JN, Spratt KF, et al. Thoracolumbar burst fractures. The clinical efficacy and outcome of nonoperative management. *Spine.* 18(8):955-70, 1993.
27) Shanmugasundaram TK: The care of SCI patients in the developing nations: can we stem the rot? Paraplegia 26(1):10–1, 1988.
28) Upendra B, Mahesh B, Sharma L, et al. Correlation of outcome measures with epidemiological factors in thoracolumbar spinal trauma. Indian J Orthop 41:290-4, 2007.
29) Vaccaro AR, Lehman RA Jr, Hurlbert RJ, et al. A new classification of thoracolumbar injuries:

the importance of injury morphology, the integrity of the posterior ligamentous complex, and neurologic status. Spine 30:2325-33, 2005.

30) Van Asbeck FW, Post MW, Pangalila RF. An epidemiological description of spinal cord injuries in The Netherlands in 1994. Spinal Cord 2000;38:420–4.

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الملخص العربي

مقدمة: يعتبر المنظار الصدري أحد الوسائل الغزوية الصغرى التي تم استخدامها و تطبيقها مؤخرا في جراحات العمود الفقري.

الوسائل: قمنا بإجراء ذلك العمل البحثي لاكتشاف مدى إمكانية تطبيق تلك التقنية في علاج كسور العمود الفقري في المنطقة الصدرية القطنية، و مدى فعاليتها، مع تقييم نتائجها الجمالية. تم اختيار المرضى على مرحلتين؛ أولا اختيار الحالات التي تحتاج للتدخل الجراحي، و ثانيا اختيار الحالات التي تحتاج لإعادة بناء الفقرات بالإضافة لعملية التثبيت الخلفي. تم إجراء الجراحات للمرضى في وضع النوم على البطن و عمل التثبيت الخلفي بواسطة مسامير و قضبان ثم إعادة بناء جسم الفقرة المكسورة بواسطة المنظار الصدري في نفس الوضع الجراحي. تم متابعة الحالات لمدة اثنا عشر شهرا.

النتائج: تراوحت أعمار المرضى بين ٢٢-٥٦ عاما، و شملت ٨ ذكور و ٧ إناث. كان أهم أسباب الكسور السقوط من العلو، و كانت أكثر الفقرات تعرضا للكسر هي الفقرة القطنية الأولى. تم إعادة بناء الفقرات في حالتين بواسطة أقفاص فقارية أما في باقي الحالات بواسطة عظام من الحوض. أظهرت الحالات جميعا التئام تام بالعظام ماعدا حالتين فقط و ذلك في نهاية فترة المتابعة. لم تحدث أي حالات وفاة أو مضاعفات ذات بال.

الاستنتاج: جراحات العمود الفقري بواسطة المنظار الصدري هي جراحات فعالة و آمنة تحتاج إلى المزيد من التدريب لتوسيع نطاق تطبيقها على جراحات العمود الفقري.