

ASSESSMENT OF PERCUTANEOUS PEDICLE
SCREW FIXATION IN MANAGEMENT
OF TRAUMATIC THORACOLUMBAR
SPINE FRACTURES; LOCAL STUDY AT
SUEZ CANAL UNIVERSITY HOSPITAL

Assessment of Percutaneous Pedicle Screw Fixation in Management of Traumatic Thoracolumbar Spine Fractures; Local Study at Suez Canal University Hospital

Mohamed Hasanein MD, Mohamed Elkazaz MD.

Department of Neurosurgery, Faculty of Medicine, Suez Canal University, Ismailia, Egypt.

Abstract

Background Data: Management of thoracolumbar fractures using the traditional posterior approach is associated with extensive paravertebral muscles damage and high postoperative morbidity. Minimally invasive percutaneous pedicle screw fixation is a highly valuable alternative for minimizing approach related morbidity. This technique ensures preservation of posterior musculature, less blood loss, less postoperative pain and shorter hospital stay.

Purpose: To evaluate efficacy of percutaneous pedicle screw fixation in the treatment of traumatic thoracolumbar fractures.

Study design: Descriptive cohort clinical case study.

Patients and Methods: Thirty patients aged 18 to 50 years, with thoracolumbar fractures (AO types A1, A2 & A3) and neurologically intact underwent percutaneous pedicle screw fixation using

Received on: January 3rd, 2017

Accepted on: March 1st, 2017

Medtronic longitude II system. Patients with kyphotic deformity $>45^\circ$, body mass index (BMI) >30 , or osteoporotic spine were excluded. Back pain scores on visual analogue scale (VAS) and radiological parameters (Cobb's angle, vertebral height loss, and anterior vertebral wedging) were compared pre and postoperatively. At final follow up, clinical outcome was assessed based on modified Macnab criteria.

Results: The mean operative time was 135 minutes, and the mean intraoperative blood loss was 115 ml. The average preoperative VAS score of back pain was 5 and improved to 2.8 postoperatively. Mean hospital stay was 4 days. Patients were followed up for 8 to 12 months. Preoperative mean Cobb's angle was 10.8° and improved to 5.6° postoperatively. The rate of misplaced screws was 11.8%. Based on the modified Macnab criteria, the final clinical outcome was excellent in 12, good in 16, and fair in 2 patients with a general patient satisfaction rate (excellent to good recovery) of 93%.

Conclusion: our data suggest that this minimally invasive technique is safe and effective treatment in AO type A thoracolumbar fractures without neurological compromise. (2017ESJ128)

Keywords: percutaneous fixation, thoracolumbar spine, trauma

Introduction

The transition from the relatively stiff thoracic spine to the more dynamic lumbar spine subjects the thoracolumbar spine to significant biomechanical stress.²⁹ This causes fractures of this region to be the commonest injury of the vertebral column, resembling nearly 60% of all traumatic spinal fractures.^{10,18} Injuries of the thoracolumbar spine ranges from compression fractures to flexion distraction injuries or fracture dislocation which can result in significant disability, deformity and neurological deficits.¹² Management of thoracolumbar fractures aims at stabilisation of the traumatized segments to achieve sound vertebral healing. This can be ascertained by using pedicle screw fixation that allows rigid stable constructs, earlier mobilization, and better deformity correction through providing three column spinal fixation.¹⁰ The efficacy and safety of traditional open techniques for pedicle screw placement has been well documented.²⁹ However, open techniques require extensive paravertebral muscle dissection and retraction which results in muscle denervation, de-vascularization, and

muscle atrophy.^{8,9} Add more, wide exposure and associated iatrogenic soft tissue injury increase intraoperative bleeding, increase the risk of infection, create significant postsurgical scarring, and can affect the stability of adjacent levels over the long term.²⁰ Eventually, these shortcomings can affect the strength of back, prolong rehabilitation time, and induce chronic back pain which potentially delay the functional recovery.^{28,14}

To minimize open approach-related morbidity, percutaneous pedicle screw fixation has been introduced as a novel technique of spinal fixation. Placement of pedicle screws percutaneously was first introduced by Magerl in 1977 as a temporary external spinal fixation to determine symptomatic disc levels before performing a spinal fusion.¹³ In 2001, Foley et al,⁵ placed the first pre-curved rods onto percutaneously implanted pedicular screws in degenerative spinal disorder. The application of percutaneous pedicular fixation was initially limited to the lumbar spine.² later on, improvement in minimally invasive technologies has led to availability of more

versatile instrumentations that can be used in different regions or pathologies.^{3,15}

The aim of the current study is to evaluate the efficacy and safety of percutaneous pedicle screw fixation in the management of relatively stable thoracolumbar fractures without neurologic compromise.

Patients and Methods

From March 2014 to March 2016, 30 patients suffered traumatic thoracolumbar fractures were involved in a prospective cohort study at Suez Canal university hospital. Inclusion criteria were; age between 18 and 50 years, and AO type A1, A2 or A3 thoracolumbar fracture without neurological deficit. We excluded patients with kyphotic deformity $>45^\circ$, obesity with BMI >30 , or have bone disorders like osteoporosis or osteomalacia. Patients were treated with percutaneous pedicle screw fixation using the Medtronic Longitude II system under fluoroscopy.

Data included mechanism of injury, fracture type and level, pre and postoperative visual analogue scale evaluation for back pain, operative time and blood loss, complications and hospitalization time. Radiological parameters including the Cobb's angle of kyphosis, percentage of vertebral body height reduction, and percentage of anterior wedging of the fractured vertebral body were compared pre and postoperatively using plain radiographs. Accuracy of pedicle screw placement was evaluated using CT scan of the thoracolumbar spine in selected cases. Clinical outcome was assessed using modified Macnab criteria¹¹ at final follow up.

Results

The study included 21 (70%) males and 9 (30%) females. Their ages ranged from 18 to 50 years

(mean 31 years). Falls were the mode of injury in 57%, followed by road traffic accidents in 43% of patients. Preoperatively, back pain scores on VAS ranged from 4 in 40% to 9 in 3.3% of patients (Mean 5 ± 3.8 SD). (Figure 1) Level of fracture was D12 in 13, L1 in 7, D11 in 6, and L2 in 4 patients. Fracture type according to AO classification was A1 in 18, A2 in 7 and A3 in 5 patients. (Table 1) Preoperative radiographs revealed; a mean Cobb's angle of kyphosis 10.8° and ranged from 5° to 19.5° . The percentage of mean vertebral body height reduction was 39.6% and ranged from 34% to 51%. The percentage of mean anterior wedging of the vertebral body was 35.6% and ranged from 27% to 55%. All patients were treated using Medtronic Longitude II™ multi-level percutaneous fixation system.

A total number of 144 polyaxial pedicle screws were inserted under fluoroscopic guidance, with a mean of 4.6 ± 0.81 screws per patient (range from 4 to 8 screws). The mean operative time was 135 minutes (minimum of 125, maximum 240 minutes), and the mean intraoperative blood loss was 115 ml (minimum of 45, maximum of 200 ml). Early in the study, two percutaneous procedures were aborted and turned into open approach due to bad quality fluoroscopy, and both excluded from the study. The mean hospital stay was four days (min. 2, max. 11 days). Follow-up period ranged from 8 to 12 months. At final follow-up visit, back pain scores on VAS showed improvement with scores ranged from 1 (mild pain) to 5 (distressing pain) with a mean score of 2.8 ± 1.3 .

Follow-up postoperative radiographs revealed; a Cobb's angle averaged 5.6° representing a mean of 5.2° correction of kyphosis, the percentage of mean vertebral body height reduction became 20.3% representing about 19.3% improvement, and the percentage of mean anterior wedging of the vertebral

body became 10.2% representing about 25.4% improvement. (Table 2) Misplaced screws were noted in 6 patients (17 screws, 11.8%) including 11 screws deviated laterally and 6 screws deviated medially. Further CT assessment revealed minimal cortical breach (<2mm) in 9 screws to moderate breach (2-4mm) in 8 screws.

Evaluation of patient satisfaction after surgery using Modified Macnab Criteria was excellent in 40%, good in 53% and fair in less than 7% of overall patients. (Figure 2) None of our patients exhibited poor recovery, wound infection or additional neurological deficit during follow-up. (Figure 3,4,5)

Table 1. Demographics of the Study Population.

Variable	No. (%)	
Gender	Male	21 (70%)
	Female	9 (30%)
Age	<20 Y	4 (13%)
	<30 Y	8 (27%)
	<40 Y	11 (37%)
	≤50 Y	7 (23%)
Level of fracture	D11	6 (20%)
	D12	13 (43%)
	L1	7 (23%)
	L2	4 (13%)
Fracture type (AO)	A 1	18 (60%)
	A2	7 (23%)
	A3	5 (17%)
Mechanism of injury	Fall	17 (57%)
	Road traffic	13 (43%)

Table 2. Radiological Evaluation Pre- and Post-operative Parameters.

Parameters	Preoperative	Final follow-up
Cobb's angle of spinal curve	10.8° (5-19.5°)	5.6° (4°-13°)
Reduction of vertebral body height (%)	39.6% (31-51%)	20.3% (26-47%)
Anterior vertebral compression (%)	35.6 % (27.8-51.2%)	10.2% (17-38%)

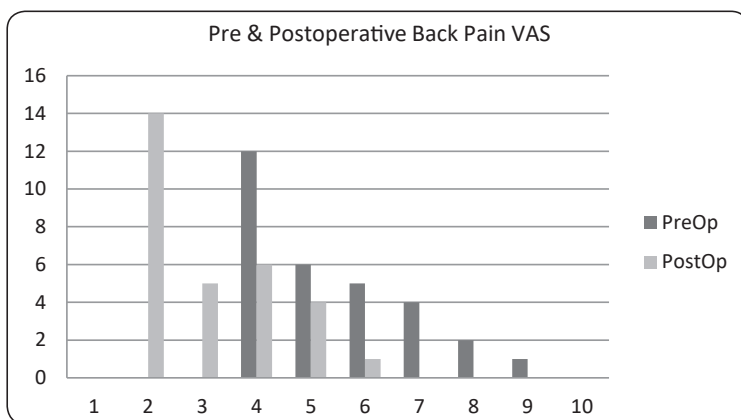


Figure 1. Pre- and Post-Operative Back Pain VAS

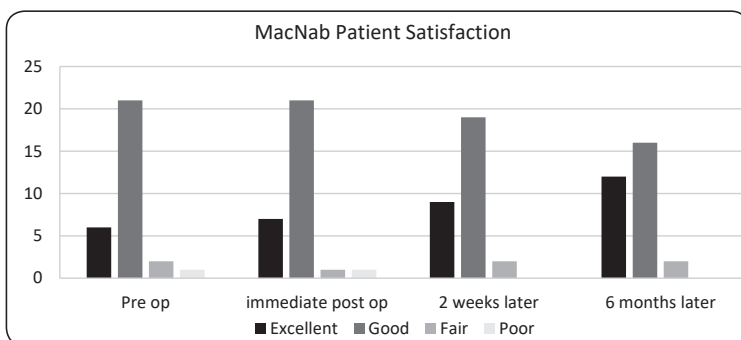


Figure 2. Patient Satisfaction According to Modified MacNab Criteria

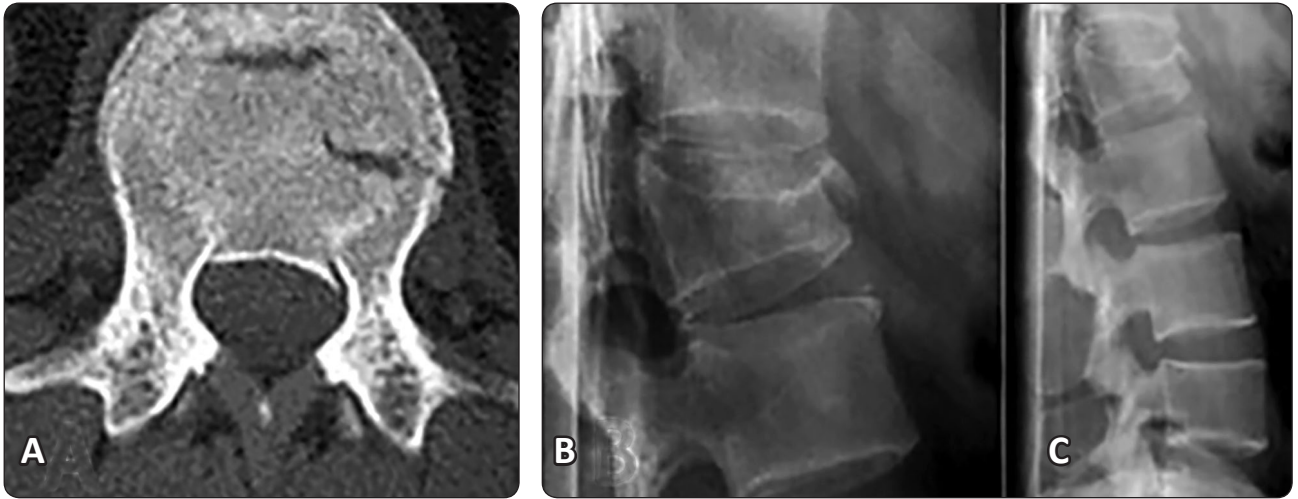


Figure 3. Illustrative patient aged 25 years old male, Presented with AO type A3 fracture of L1, without neurological deficit. (A) Axial view of CT spine (B) Sagittal view of CT spine.

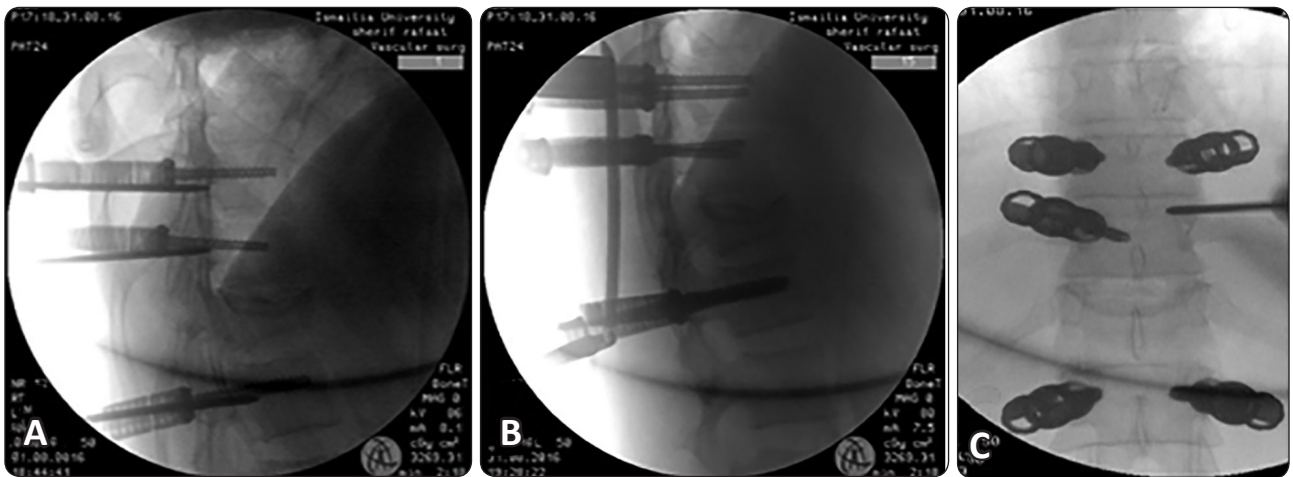


Figure 4. Show percutaneous screw insertion procedure. (A) Pedicle cannulation. (B) Rod insertion and (C) AP view of pedicle cannulation.

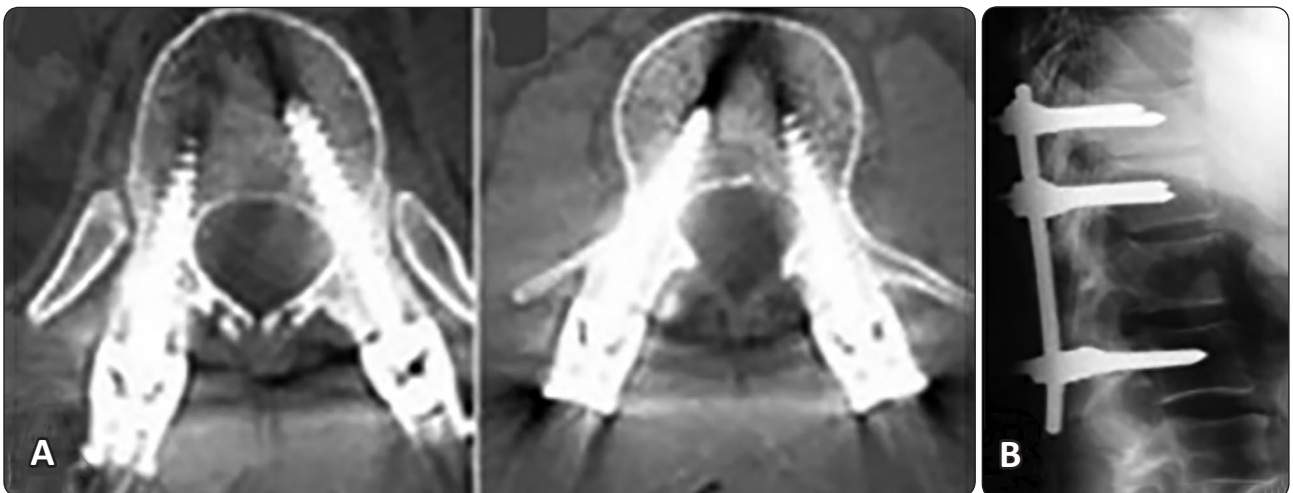


Figure 5. Post-surgical fixation shows (A) Axial view shows pedicular screws insertion. (B) Sagittal view shows good alignment of thoracolumbar spine.

Discussion

Pedicle screw fixation procedures are reliable methods of spinal stabilisation for a wide variety of spinal disorders. However, conventional posterior instrumentations are commonly associated with some drawbacks including extensive muscle dissection and denervation, greater blood loss, considerable postoperative pain, and sometimes functional impairment.^{6,19} Recently, various minimally invasive techniques with percutaneous transpedicular screw fixation were introduced, especially for lumbar and thoracolumbar disorders to minimize the open approach-related drawbacks.^{7,26} In this study, we performed percutaneous pedicle screw fixation using polyaxial screws without fusion for patients presented with AO type A thoracolumbar fractures and neurologically intact. Fixation alone can be considered for fractures with temporary bone instability and high power of spontaneous healing after immobilization as it provides pain relief, corrects the deformation and avoids any additional displacements.^{3,16} In a randomized study compared pedicle instrumentation with and without fusion, Wang et al,²⁷ demonstrated better results in the group without fusion. On the other side, other studies^{4,16} showed that pedicle fixation with fusion seems better for highly comminuted fractures and fractures with significant anterior vertebral wedging. Our average intraoperative blood loss was 115 ml which is consistent with previous studies that reported average intraoperative blood loss ranged from 88 ml to 194 ml,^{16,29} while the average operative time was 135 minutes which is little longer than the average operative times reported in previous studies (87 min to 120 min),^{17,29} but it improved later with the progression of our learning curve. Postoperatively, all patients required supplementary analgesics, but none

of them required narcotics. The majority of our patients exhibited an improvement of back pain according to the VAS with a pain reduction from 5 ± 3.8 preoperatively to 2.8 ± 1.3 at final follow up. Wang et al,²⁴ published an average postoperative VAS score of 2.2 ± 0.8 for open fixation group and 1.5 ± 0.9 for percutaneous fixation group which impacted on earlier mobilization, shorter recovery time, shortened hospital stay, and reduced hospital costs for percutaneous fixation group. The final Cobb's angle of kyphosis averaged 5.6° which is comparable to the results reported by Palmisani et al,¹⁷ in a study comprised 51 patients with thoracolumbar fractures treated by percutaneous pedicular fixation and a final mean Cobb's angle of 7.8° , and the results published by Ni W et al,¹⁶ who performed percutaneous pedicle fixation of thoracolumbar fractures without neurological deficits and reported a final mean Cobb's angle of 8.9° . In current study, 144 screws were inserted in 30 patients. The rate of pedicular cortical breach was 11.8%, but all were of mild to moderate degree. None of the misplaced screws resulted in neurological injury or required revision. Schizas et al,²² reported a screw perforation rate of 23% in 60 percutaneous screws inserted under fluoroscopy. In another study comprised 115 percutaneous screws, Ringel et al,²¹ reported a cortical breach rate of 13% with need for revision surgery for 9 misplaced screws. Percutaneous pedicle fixation entails a precise screw placement which requires a high quality intra-operative imaging that unfortunately increases operating time, and surgeon/patient exposure to ionizing radiation.³

In 2016 in a similar study by Abdelbaky A,¹ stated that Mean operative time was 110 minute. Mean days of hospitalization was 3. Only 7% of pedicle screws had a less than

2 mm pedicle breach with no neurological deficit. Taha H,²³ Stated that the average time of hospitalization was 3 days with no necessary oral analgesia on discharge in 63% of cases. The mean of VAS post-operative was 1.6 in the follow up. After 6 months from surgery all patients showed perfect vertebral reconstruction with improved vertebral body angle and Cobb's angle where vertebral body angle changed from 10.4 degrees to 6.2 degrees post-operatively and Cobb's angle ranged from 4.9 degrees to -6.3 degrees. Screw accuracy in pedicle showed a 5.4% misplaced screws.

In a comparative prospect between open versus minimal invasive percutaneous fixation technique, Wang et al,²⁵ it showed nearly similar results related to percutaneous fixation and it is better than traditional open technique related to surgical time, blood loss, hospital stay and use of narcotics post-operative. While there is no significant difference related to infection rate and screw positioning. For clinical outcome evaluation, we used Modified Macnab Criteria with an overall patient satisfaction rate of 93% (40% excellent recovery, 53% good recovery) which is comparable with the results published by Wang et al with a reported satisfaction rate of 88.2% (52% excellent, 35% good).

Conclusion

The data reported in this study suggest that percutaneous pedicle screw fixation suggest is a safe and reliable alternative to open surgery in the management of type A thoracolumbar fractures not associated with neurologic compromise. Much radiation exposure represents a limitation. However, the technique is better or comparable in terms of post operative pain, deformity correction, complication rate and return to the activities of daily living with the advantage of being minimally invasive.

References

1. Abdelbaky A: Minimally Invasive Percutaneous Transpedicular Screw Fixation of Acute Thoracolumbar Fractures. *Egy Spine J* 17:34-41, 2016
2. Anderson D, Samartzis D, Shen F: Percutaneous instrumentation of the thoracic and lumbar spine. *Orthop Clin North Am*38(3):401-408, 2007
3. Court C, Vincent C: Percutaneous fixation of thoracolumbar fractures: current concepts. *Orthop Traumatol Surg Res* 98(8):900-909, 2012
4. Dasilva L, Coutinho P, Maia R: Percutaneous pedicle fixation of thoracolumbar vertebral fractures without neurological deficits. *Columna* 12(3):238-241, 2013
5. Foley K, Gupta S, Justis J: Percutaneous pedicle screw fixation of the lumbar spine. *Neurosurg Focus* 10:1-8, 2001
6. Grass R, Biewener A, Dickopf A: Percutaneous dorsal versus open instrumentation for fractures of the thoracolumbar border. A comparative, prospective study. *Unfallchirurg* 109(4):297-305, 2006
7. Holly L, Foley K: Three-dimensional fluoroscopy-guided percutaneous thoracolumbar pedicle screw placement; Technical note. *J Neurosurg* 99(30):324-329, 2003
8. Kim D, Lee S, Chung S: Comparison of multifidus muscle atrophy and trunk extension muscle strength: percutaneous versus open pedicle screw fixation. *Spine* 30:123-129, 2005
9. Knight R: Minimally invasive spine surgery. *Curr Orthop Pract* 20:227-231, 2009
10. Leucht P, Fischer K, Muhr G: Epidemiology of traumatic spine fractures. *Injury* 40:166-172, 2009
11. Macnab: Negative disc exploration. An analysis of the causes of nerve-root

- involvement in sixty-eight patients. *The Journal of Bone & Joint Surgery* 53(5): 891-903, 197.
12. Magerl F, Aebi M, Gertzbein S: A comprehensive classification of thoracic and lumbar injuries. *Eur Spine J* 3(4):184-201, 1994
 13. Magerl F: Stabilization of the lower thoracic and lumbar spine with external skeletal fixation. *Clin Orthop Relat Res* 189:125-141, 1984
 14. Merom L, Raz N, Hamud C: Minimally invasive burst fracture fixation in the thoracolumbar region. *Orthopedics* 32:273-278, 2009
 15. Mobbs R, Sivabalan P, Li J: Technique, challenges and indications for percutaneous pedicle screw fixation. *J Clin Neurosci* 18:741-749, 2011.
 16. Ni W, Huang Y, Chi Y: Percutaneous pedicle screw fixation for neurologic intact thoracolumbar burst fractures. *J Spinal Disord Tech* 23(8):530-537, 2010
 17. Palmisani M, Gasbarrini A, Brodano G: Minimally invasive percutaneous fixation in the treatment of thoracic and lumbar spine fractures. *Eur Spine J* 18:71-74, 2009
 18. Rajasekaran S, Kanna R, Shetty A: Management of thoracolumbar spine trauma: An overview. *Indian J Orthop* 49:72-82, 2015
 19. Rampesaud Y, Annand N, Dekutoski M: Use of minimally invasive surgical technique in the management of thoracolumbar trauma. *Spine* 31(11):96-102, 2006
 20. Rehtine G, Bono P, Cahill D: Postoperative wound infection after instrumentation of thoracic and lumbar fractures. *J Orthop Trauma* 15:566-569, 2001
 21. Ringel F, Stoffel M, Stuer C: Minimally invasive transmuscular pedicle screw fixation of the thoracic and lumbar spine. *Neurosurgery* 59:361-366, 2006
 22. Schizas C, Michel J, Kosmopoulos V: Computer tomography assessment of pedicle screw insertion in percutaneous posterior transpedicular stabilization. *Eur Spine J* 16:613-617, 2007
 23. Taha H: Percutaneous Stabilization of Thoracic and Lumbar Spine Fractures. Clinical and Radiological Outcome. *Egy Spine J*, 4:34-40, 2012
 24. Wang H, Zhou Y, Liu J: Comparison of Open Versus Percutaneous Pedicle Screw Fixation Using the Sextant System in the Treatment of Traumatic Thoracolumbar Fractures. *Clin Spine Surg*:30(3):239-246, 2017
 25. Wang H, Zhou Y, Zheng F: Percutaneous pedicle screw fixation through the pedicle of fractured vertebra in the treatment of type A thoracolumbar fractures using Sextant system: an analysis of 38 cases. *Chin J Traumatol* 13(3):137-145, 2010
 26. Wang M, Anderson D, Poelstra K: Minimally invasive posterior fixation. *Neurosurgery* 63(suppl):197-203, 2008
 27. Wang S, Ma H, Liu C: Is fusion necessary for surgically treated burst fractures of the thoracolumbar and lumbar spine? a prospective, randomized study. *Spine* 31(23):2646-52, 2006
 28. Weber B, Grod D, Dvorak J: Posterior surgical approach to the lumbar spine and its effect on the multifidus muscle. *Spine* 22:1765-72. 1997
 29. Wild M, Glees M, Plieschnegger C: Five-year follow-up examination after purely minimally invasive posterior stabilization of thoracolumbar fractures: a comparison of minimally invasive percutaneously and conventionally open treated patients. *Arch Orthop Trauma Surg*:127:335-343, 2007
 30. Wood K, Li W, Ploumis A: Management of thoracolumbar spine fractures. *Spine* 14:145-164, 2014

الملخص العربي

تقييم التثبيت عبر الجلد باستخدام مسامير عنق الفقرة لعلاج كسور الفقرات الصدرية القطنية: دراسة محلية بمستشفى جامعة قناة السويس.

البيانات الخلفية: تعتبر المنطقة الإنتقالية بين الفقرات الصدرية والقطنية أكثر مناطق العمود الفقري تعرضا للإصابات وتمثل كسور هذه المنطقة حوالي ٦٠% من كسور العمود الفقري. يهدف علاج كسور هذه الفقرات إلى حدوث إلتئام متين للكسر يمنع حدوث ألم أو تشوه بالعمود الفقري، مع الحفاظ على الأنسجة العصبية من الضرر، وهو ما تضمنه جراحات تثبيت الكسور باستخدام مسامير عنق الفقرة. تستوجب هذه الجراحات إجراء شق طويل للجلد مع تشريح للعضلات المجاورة للفقرات وهو ما يؤدي الى ضرر بالتغذية الدموية و العصبية لهذه العضلات مع زيادة فى فقد للدم أثناء الجراحة، وزيادة فى ألم الظهر بعد الجراحة، مع احتمال حدوث إضطرابات وظيفية بالعمود الفقري. مع حدوث تطور فى مجال الجراحات محدودة التدخل بالإضافة الى ظهور اساليب حديثة للتصوير الإشعاعى اثناء الجراحة بدأ إستخدام طرق جديدة لتثبيت كسور الفقرات باستخدام مسامير عنق الفقرة عبر فتحات صغيرة بالجلد، مما يضمن خفض كبير لمضاعفات الجراحات التقليدية لتثبيت الفقرات.

الغرض: تقييم استخدام مسامير عنق الفقرة عبر الجلد لعلاج كسور الفقرات الصدرية القطنية.

تصميم الدراسة: دراسته سريرية وصفية.

المرضى و الطرق: فى هذه الدراسة تم جمع و مقارنة البيانات الإكلينيكية والجراحية بأثر مستقبلى لعدد ٣٠ مريض يعانون من كسور بالفقرات الصدرية القطنية غير مصحوبة بأى اضرار عصبية. خضع هؤلاء المرضى لجراحة تثبيت الفقرات باستخدام مسامير عنق الفقرة عبر الجلد بمستشفى جامعة قناة السويس فى الفترة ما بين مارس ٢٠١٤ الى مارس ٢٠١٦.

النتائج: أظهرت النتائج ان طريقة تثبيت الفقرات عبر الجلد يقلل كلا من مدة الجراحة وكمية الدم المفقود اثناء الجراحة، مع تحسن ملموس لكلا من درجة ألم الظهر بعد الجراحة و قدرة المريض على الحركة فى فترة النقاهة. أظهرت نتائج الأشعات تحسن فى زاوية حداب العمود الفقري، كما بين التقييم الوظيفى ان غالبية المرضى تعافوا بدرجة ممتازة الى جيدة مع نسبة رضاء عن الجراحة بلغت ٩٣% بين المرضى

الإستنتاج: مما سبق يستنتج أن جراحة تثبيت الفقرات الصدرية القطنية عبر الجلد تعتبر طريقة فعالة وآمنة لعلاج حالات معينة من كسور هذ الفقرات، بالإضافة الى مميزات كونها جراحة محدودة التدخل، وهو ما ينعكس على المريض فى صورة تحسن اكلينيكى أفضل وتقليل لفترة النقاهة، مع عودة أسرع لأنشطة الحياة المعتادة.