Percutaneous Stabilization of Thoracic and Lumbar Spine Fractures. Clinical and Radiological Outcome.

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Abstract

Background Data: Management of thoracolumbar fractures remains controversial. Little has been published in the literature about the use of percutaneous pedicle screws in the management of thoracic and lumbar spine fractures.

Purpose: To assess the efficacy and safety of percutaneous pedicle screw fixation in the management of thoracic and lumbar spine fractures and to report the clinical and radiological results.

Study Design: A prospective cohort of thoracic and lumbar spine fractures treated by percutaneous fixation.

Patients and Methods: Seventy eight patients with thoracic and lumbar spine fractures, 60% males and 40% females, with mean age of 31.5 years, without neurologic deficit, were treated by percutaneous transpedicular fixation and ligamentotaxis. Follow-up ranged from 6 to 40 months (mean 21 months) with clinical and radiographic evaluation.

Results: Mean hospital stay for isolated spine fractures was 3 days. 63% required no oral analgesia upon discharge. Mean VAS for back pain at latest follow up was 1.6. All patients returned to some sort of employment. Improvement in local kyphosis radiological measurement was achieved.

Conclusion: Percutaneous pedicle screw fixation is a safe and effective method for the management of selected cases of thoracic and lumbar spine fractures. All benefits of minimally invasive surgery are met in this technique. Limitations are fractures with gross instability where fusion is needed, and patients with a neurological deficit where a formal decompression is mandatory. (2012ESJ032)

Keywords: Minimally invasive, Fracture, Spine, Percutaneous, thoracolumbar, pedicle screws.

Introduction

Management of thoracolumbar fractures remains controversial. This extends to the indications of surgical treatment and the methods of surgery to be used. According to newly introduced thoracolumbar injury classification system TLICS,[24] patients with a score of 5 or more should be treated operatively, while patients scoring less than 4 are good candidates for conservative treatment. A score of 4 is a grey zone. The TLICS scoring system has introduced two important factors in the decision making; the intactness or otherwise of the posterior ligamentous complex and the neurological status of the patient. All previous classifications were either mechanistic or descriptive of the fracture pattern. Conservative treatment classically consists of bed rest,

postural reduction and placing the patient in cast or brace and physical therapy, usually 3 to 6 months, until fracture healing is noted on x-ray films.[3]

However, conservative treatment was found, to be expensive in terms of both person-hours and financial resources, and the late outcome has not been as favorable as it might be expected. Absence of the sequelae of late deformity and pain are uncertain when nonsurgical techniques are used. Moreover, conservative treatment may not be applicable practically in certain situations where it either adds to the morbidity of the patient as in polytrauma, venous disease or previous deep venous thrombosis, obesity, or significant cardio-pulmonary diseases; or considered unsafe, as in psychiatric patients or patients with mood changes after head injury. Attention must also be paid to the fact that younger and active workers refuse the conservative treatment in order to avoid bed rest and an inactive period.[19]

Materials and Methods

Seventy eight patients with 78 thoracolumbar spine fractures have been treated by indirect decompression and stabilization of their fractures by percutaneous transpedicular fixation and ligamentotaxis since May 2006 until October 2010. 31 patients (40%) were females, 47 males (60%); patient age ranged from 17 to 54 (mean 31.5 years). Mode of trauma ranged from motor vehicle accidents in 38 patients (49%), fall from a height in 36 patients (46%) and fall of a weight on the patient's back in 4 patients (5%). 30 patients (39%) were polytrauma patients. all our patients were neurologically free, Frankel classification (E).[4] Using TLICS classification, 58 patients scored 2 (74%), 16 patients scored 4 (20%) and 2 patients -with chance fracture type- scored 7 (Table 1). Using AO-Magerl classification[15], 74 patients (95%) were type A, 3 patients were type B, and 1 patient was type C (Table 2).

Regarding indications, patients in our series fell into three categories; those with a score of 5 or more on TLICS and scored less than 7 on the load sharing classification[17] were clear candidates for operative treatment, meaning that they required posterior surgery only (4 patients).

The second category were patients that scored 4 or less on TLICS, but because of associated injuries or associated co-morbidities such as obesity, cardiopulmonary, psychiatric or previous history of thrombo-embolism, they were unfit for non-operative treatment and were offered posterior percutaneous stabilization (26 patients).

The third category was patients who scored 4 or less on TLICS and were therefore candidates for conservative treatment. These patients were given the choice of either conservative treatment or percutaneous fixation. Forty eight patients opted for percutaneous fixation.

Level of the fracture was in thoracic spine (T1–T10) in 5 patients (7%), thoracolumbar junction (T11–L2) in 51 patients (65%) and lumbar spine in 22 patients (28%) (Table 3); All patients had no neurological deficit.

All the patients have been followed up with clinical and radiological evaluation for a mean 21 months (ranged from 6 to 40 months). Operative time ranged from 45 to 150 minutes with a mean of 70 minutes. Blood loss has been negligible in all our cases (less than 100 ml). Sextant (Medtronic) instrumentation system was used in all patients. No external support was used for any of the patients, mobilization and walking was allowed as tolerated by the patients and according to their response to pain.

Table 1. Fracture score following TLICS system

TLICS score	No. of patients
2	58
4	16
6	2
7	2

Table 2. Fracture type according to AO classification[15]

AO-Magerl type	No. of patients
A1	34
A2	19
A3	21
B1	2
B2	1
C1	1

Table 3. Different fracture levels

Level	No. of Patients
T9	2
T10	3
T11	4
T12	7
L1	21
L2	19
L3	13
L4	7
L5	2

Results

The average hospital stay for patients with isolated spine fractures was 3 days. Oral analgesia was unnecessary upon discharge in 63% of all patients. Visual analogue scale (VAS) was used for the evaluation of pain postop. The mean VAS value was 1.6 points at latest follow up. For movement of the spine measured by finger to ground distance, 34 patients (44%) were excellent and 30 patients (38%) were good; that is finger to ground distance ≤ 15 cm or ≤30 respectively. 63% of the patients were able to return to a previous physically demanding employment or activities. All other patients returned to some form of employment at an average 10 months after injury.

After 6 months follow up, all patients showed good radiologic reconstruction of the anterior and posterior columns, and were all considered healed. Cobb's angle CA, vertebral body angle VBA and the anterior vertebral body compression percentage AVBCP were the measures used in radiological evaluation.[12] (Table 4) shows the preoperative, postoperative and last follow-up mean values. The loss of correction at follow up was found to be less in the VBA than in CA.

Pedicle screw accuracy was assessed by post-operative CT scan, 2-mm increment deviation classification initially presented by Gertzbein and Robbins[6] in 1990. Of the 312 screws used in this series, only 3 screws fell in group 5 and of these three, one only was misplaced medially encroaching into the spinal canal, the other two were misplaced laterally. Groups 1 and 2 are considered accurately placed screws while groups 3 to 5 are considered misplaced screws. Therefore, 5.4% of the screws were misplaced. (Table 5) shows the accuracy of screws.

Complications:

A screw has been positioned medially, encroaching into the spine canal, without neurological consequences. Implant failure, in term of disengagement of the rod from the screws in one side, occurred in one patient. The failed construct was removed on that side and patient continued with one side fixation till healing. Two patients developed superficial infection which was controlled by intravenous antibiotics.

Discussion

This paper describes the successful use of percutaneous pedicle screw fixation in the management of thoracic and lumbar spine fractures. It evaluated the clinical and radiological outcomes of this technique.

The conventional posterior approach to the thoracolumbar spine entails muscle stripping and detachment to expose the posterior elements of the spine far lateral to the tips of the transverse processes. This is necessary to provide enough space for lateral-to-medial orientation for optimum screw placement. This approach has shown definite radiologic evidence of paraspinal muscle volume shrinkage and scarring. It has also shown electromyography evidence of muscle denervation and on clinical levels inability to restore muscle power post surgery. This approach also entails the use of self retaining retractors which have been shown to produce time-dependent paraspinal muscle injury evidenced by CPK enzyme levels.[1,5,7,8,9,10,11,16,22,23] All these negative effects upon the paraspinal muscles are theoretically minimized in percutaneous pedicle screw fixation. Indeed, Kim et al[13] compared percutaneous pedicle screw fixation and the conventional open method using MRI and back muscle performance. They concluded that percutaneous pedicle screw fixation caused less

Table 4. Mean radiological values at preoperative, postoperative and last follow-up

	Pre-Op	Post-Op	Last Follow up
VBA	10.4˚	6.2˚	7.7˚
CA	4.9˚	-6.3˚	-4.2˚
AVBCP	31.5%	17.2%	22.5%

NB. VBA: Vertebral Body Angle, CA: Cobb Angle, AVBCP: Anterior Vertebral Body Compression Percentage

Table 5. Pedicle screw accuracy[6]

Group	Position	No. of Screws
1	Perfect within pedicle	160
2	Deviating < 2mm	135
3	Deviating 2 to 4mm	9
4	Deviating 4 to 6mm	5
5	More than 6mm	3

paraspinal muscle damage than open pedicle screw fixation and had positive effects on postoperative trunk muscle performance.

Blood loss in this series was negligible, the mean blood loss being less than 100 mls. Others[18] have had similar blood loss. Wild et al[26] compared conventional open surgery versus percutaneous fixation and showed significantly lower blood loss in the percutaneous group. Operative time in this series was a mean of 70 minutes. Clearly, our operative time decreased along the learning curve. Others[20] have had similar operative time.

In standard open pedicle screw fixation, screws are placed using anatomic landmarks, probing of the screws tracts to feel for breaches and fluoroscopy. Still, the reported rate of screw misplacement in open surgery has been estimated to be as high as 10%–20%.[2] A meta-analysis reported an overall accuracy rate of 91.3%.[14] Percutaneous pedicle screw fixation substitutes this lack of tactile feedback with a heavy reliance on imaging to guide the screws. This turns out to be a safe option, as evidenced by the low screw misplacement rate of 5.4% in this case series. Others have reported misplacement around the 5% rate.[27] A heavy reliance on imaging, however, translates into more radiation exposure to the patient and surgeons. Roux et al compared seven minimally invasive procedures regarding fluoroscopy radiation exposure. They found that percutaneous fixation of the spine had the highest radiation exposure; equivalent to 13 short trochanteric nails or 174 wrist fracture k-wire fixation.[20] The effect of this high radiation exposure upon the patient and surgeon remains a concern and needs to be determined in future studies. The use of surgical navigation equipment can significantly decrease the extent of radiation exposure.

One of the main concerns of percutaneous fixation is the lack of bony fusion. However, the necessity of fusion for thoraco-lumbar burst fractures have constantly been challenged and debated by numerous authors. Recently, Wang et al showed that short segmental fixation without fusion for surgically treated burst fractures was satisfactory.[25] Sanderson et al has also shown that short segment pedicle screw fixation without fusion could achieve satisfactory results for unstable thoracolumbar fractures.[21] These studies further substantiate percutaneous fixation as a good alternative to the open technique.

Percutaneous fixation is a relatively new minimally invasive procedure and all classifications including TLICS did not consider it as an option for management of thoracolumbar fractures. I have used this classification in purpose to show that although many of these fractures might be treated conservatively, percutaneous fixation may be an option, particularly with the low morbidity and high safety of the procedure.

It may be argued that many cases of this series had a score less than 4 on the TLICS classification and therefore were candidates for conservative treatment. Therefore, offering these patients surgery might be an overtreatment. However, it is important to note that all classifications available to us, including TLICS, did not consider percutaneous fixation as an option for treatment of thoracolumbar fractures. Percutaneous fixation might be considered as an intermediate between open fixation and conservative treatment. Therefore, with more experience gained and more clinical research, percutaneous fixation might be integrated in revised classifications in the future. Over the last two decades, indications for surgery have changed dramatically in the management of many fractures. Examples include clavicle fractures. This may similarly happen in thoracic and lumbar spine fractures.

Limitations to this minimally invasive percutaneous stabilization are: grossly unstable fractures where bone grafting for fusion is necessary as well as the presence of a neurological deficit, especially if incomplete, where direct decompression of the spinal canal is recommended; both of which are not feasible through this technique.

Conclusion

This series have shown the successful use of percutaneous pedicle screw fixation in the management of selected cases of thoracic and lumbar fractures. The percutaneous approach provides certain advantages similar to other minimally invasive procedures. Limitations include grossly unstable fractures where fusion is needed and the presence of a neurological deficit where decompression of the neural elements is mandatory.

Figure 1. MG 40 year old male sustained a type A fracture of L2 in a RTA**. (a)** preop lateral view. **(b)** preop sagittal CT**. (c)** postop AP view. **(d)** postop lateral view. Note the correction of the local kyphosis. **(e)** postop CT showing accurate placement of the pedicle screws; left screw grade 1 and right screw grade 2.

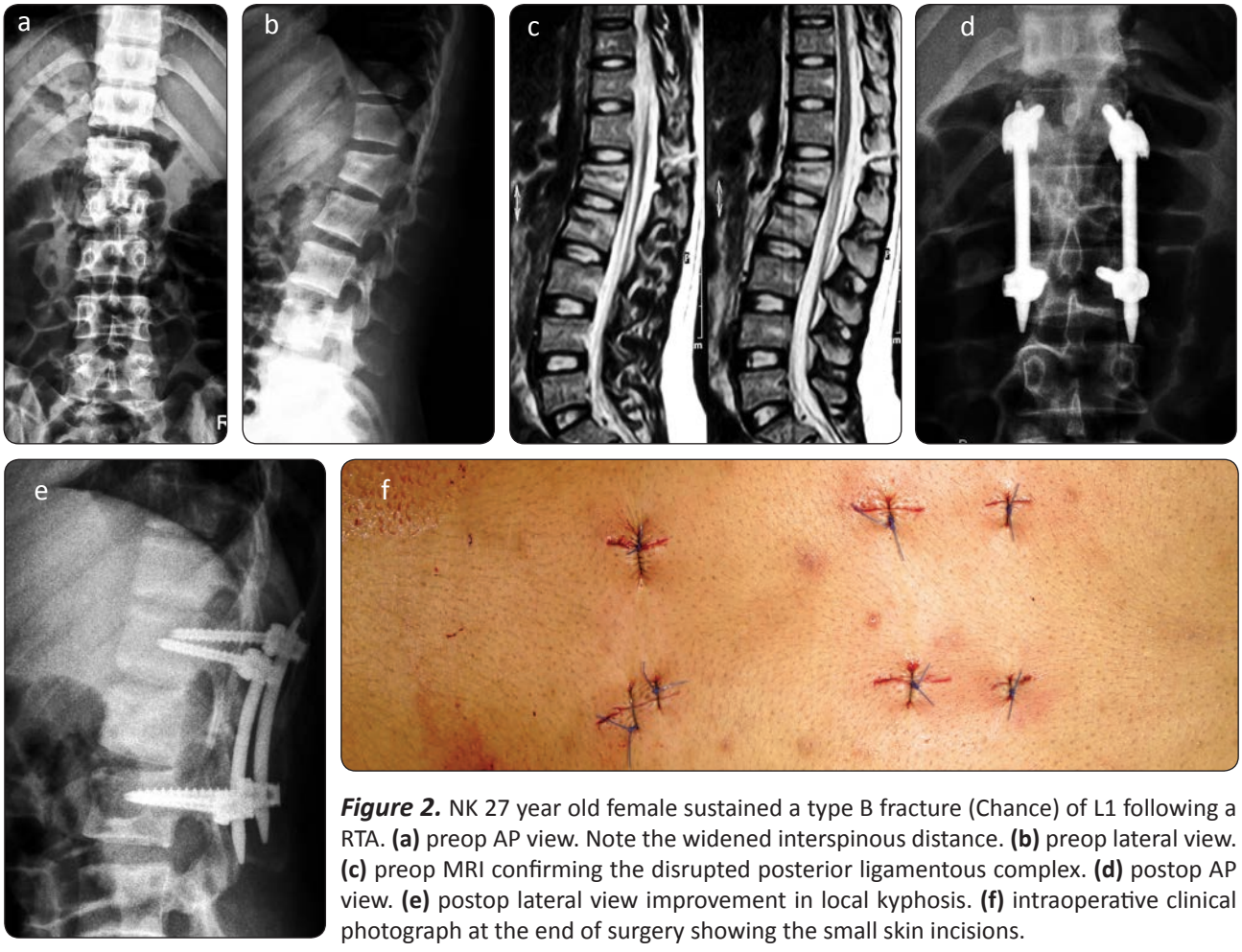

Figure 2. NK 27 year old female sustained a type B fracture (Chance) of L1 following a RTA. **(a)** preop AP view. Note the widened interspinous distance. **(b)** preop lateral view. **(c)** preop MRI confirming the disrupted posterior ligamentous complex. **(d)** postop AP view. **(e)** postop lateral view improvement in local kyphosis. **(f)** intraoperative clinical photograph at the end of surgery showing the small skin incisions.

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الملخص العربي

تثبيت كسور الفقرات الصدرية والقطنية عن طريق الجلد. النتائج السريرية و الأشعية

بيانات أساسية: علاج كسور الفقرات الصدرية والقطنية ما زال مثيرا للجدل. تم نشر القليل من الأبحاث في استخدام مسامير السويقة عن طريق الجلد في علاج كسور الفقرات الصدرية والقطنية.

الغرض: لتقييم فعالية وسلامة تثبيت كسور الفقرات الصدرية والقطنية عن طريق الجلد وتقديم تقرير عن النتائج السريرية والإشعاعية.

تصميم الدراسة: لفيف من كسور الفقرات الصدرية والقطنية المحتملين يتم علاجهم بواسطة التثبيت عن طريق الجلد.

المواد والأساليب: تم علاج المرضى الذين يعانون من ٧٨ كسر بالفقرات الصدرية والقطنية بواسطة التثبيت عن طريق الجلد ، و كان الذكور ٦٠٪ والإناث ٤٠٪، مع متوسط العمر ٣١,٥ سنة. جميع المرضى كانوا دون عجز عصبي. فترة المتابعة تتراوح بين ٦ إلى ٤٠ شهرا (متوسط ٢١ شهرا) مع التقييم السريري والشعاعي. كان متوسط البقاء في المستشفى لكسور العمود الفقري المعزولة ٣ أيام.

النتائج: ٦٣٪ من المرضى لا يلزمهم مسكنات عن طريق الفم عند الخروج من المستشفى. كان متوسط (VAS) لآلام الظهر في أحدث متابعة ١,٦. عاد جميع المرضى إلى نوع من العمالة. وقد تحقق تحسن في القياس الإشعاعي للحداب المحلي.

مناقشة: يتم تحقيق جميع مزايا الإجراءات ذات التدخل المحدود بالعمود الفقري مع هذه التقنية. القيود هي الكسور ذات عدم الاستقرار الإجمالي التي تحتاج إلى الالتحام، والمرضى الذين يعانون من قصور عصبي حيث تخفيف الضغط عن الأعصاب إلزامي.

الخلاصة: تثبيت مسامير السويق عن طريق الجلد هي وسيلة آمنة وفعالة لعلاج حالات مختارة لكسور الفقرات الصدرية والقطنية. جميع مزايا الإجراءات ذات التدخل المحدود بالعمود الفقري متحققة مع هذه التقنية.