Clinical Article

Online ISSN : 2314-8969
Print ISSN: 2314-8950

Egy Spine J 21:33-41, 2017

www.esa.org.eg

Pedicle Subtraction Osteotomy in Treatment of Posttraumatic Kyphosis

Ahmed A Arab MD, Mohamed M Elmaghrabi MD, Mohamed H Eltantawy MD

Department of Neurosurgery, Faculty of Medicine, Benha University, Benha, Egypt.

Abstract

Background Data: One of the worst complications of spine fracture is posttraumatic kyphosis, and beside pain and disability, new neurological deficit may develop and need surgical interference, that is challenging.

Purpose: To assess the technique of pedicle subtraction osteotomy as a single posterior approach in treatment of posttraumatic kyphosis.

Study Design: A prospective clinical cohort study.

Patients and Methods: we recruited for this study 12 patients, 8 males and 4 females. The mean was age (31.25±9.39 years). All patients suffered symptomatic posttraumatic kyphosis and were treated surgically using pedicle subtraction technique at the Neurosurgery Department of Benha University Hospital through the period from February 2013 to April 2015. The mean period of follow up was (24.08±6.89 months). Analysis was performed with use of before-and-after pain scale, disability scale, and degree of correction. Complications and radiographic findings, and personal satisfaction from surgery were analyzed.

Results: Statistically significant correction of kyphotic angle was obtained from (28.25° to 43.50°) to (3.25° to 10.25°) (P=0.002). Patients showed improvement in pain scale from (6.13 to 7.5) to (1.0 to 2.0) (P=0.002). Disability scale improved from (6.0 to 8.0) to (1.25 to 3.0) (P=0.003). No neurological complication had occurred. 91.6% of patients were satisfied from surgery.

Conclusion: Pedicle subtraction osteotomy is a safe and effective technique for management of posttraumatic kyphosis, and can obtain satisfactory result. According to our results, a safe degree of 45 of correction could be obtained. (2016ESJ136)

Keywords: postraumatic kyphosis; pedicle subtraction osteotomy; trauma; deformity

Received on:
October 1st, 2016

Accepted on:
December 17th, 2016

Introduction

Posttraumatic kyphosis (PTK) may occur in patients who have received either surgical or nonsurgical treatment.[13] The Magerl et al,[18] classification of thoracolumbar spinal injuries recognizes three injury types. In serious injuries, a secondary posttraumatic deformity may develop. pain, progressive deformity, new neurological damage or increasing neurological deficit and skin problems and these are the main indications for surgery.[1,2] Late deformities, in which the kyphosis does not occur immediately, may be caused by factors that related to or not to the treatment procedure. Implant failure, deep infection, pseudarthrosis, short fusion, prior laminectomy are the most common causes of late deformity related to treatment procedure.[16,19,22,24]

Surgical approaches include anterior, posterior, or combined anterior and posterior approaches are well known approaches .[15] Among the correction procedures, pedicle subtraction osteotomy (PSO) was developed to achieve significant correction of kyphosis or restoration of lordosis by a single stage posterior approach procedure.[3,17,23] Buchowski et al,[6] recently reviewed the literature concerning post-traumatic kyphosis and recommended the use of PSO in cases associated with normal sagittal balance and sharp angular deformity.

In this study we evaluated the clinical and radiological results of PSO in treatment of symptomatic posttraumatic kyphotic deformity.

Patients and Methods

This is a prospective clinical cohort study of twelve patients who had been included in this study. All patients suffered from symptomatic posttraumatic kyphosis after initial surgical and nonsurgical treatment and were treated by one stage posterior approach with pedicle subtraction osteotomy and instrumentation. All patients were treated at the Neurosurgery Department of Benha University Hospital through the period from February 2013 to April 2015.

There were eight males and four females patients included in this study. Four patients had delayed kyphosis after conservative treatment, three patients had delayed kyphosis after primary decompressive laminectomy without instrumentation, two patients had kyphosis after failed instrumentation, two patients had kyphosis after inadequate short fusion, and one patient had old healed deformed fracture with newly developed pain.

All patients underwent detailed history; particular attention was given to symptoms suggesting neurological involvement and sphincter troubles. Physical examination along with neurologic examination was done. All patients were subjected to a subjective questionnaire preoperatively and at the time of the most recent follow-up. The content validity of the questionnaire was confirmed by a team of three experts of neurosurgeons. The questionnaire was first written in English and translated to Arabic which is then translated back to English in order to ensure that the translated version gives the proper meaning. Both the preoperative and postoperative questionnaires included a Visual Analogue Scale (VAS), rated on a scale from 1 to 10, for pain and impairment. Patient satisfaction from the surgery was also determined subjectively as excellent (ready to do again the same procedure for the same problem), good (the surgery improved the status but did not merit all the patient's expectations), fair (the patient's status did not changed with surgery), and poor (when the surgery has worsened the

patient's condition). Computerized Tomography (CT) and Magnetic Resonance Imaging (MRI) were done preoperatively for all patients for the reasons of completing radiological assessment and recording the radiological state of the neurological tissue. Standing anteroposterior and lateral radiographs were made preoperatively and at regular postoperative follow-up. PTK was ascertained by drawing the lines parallel with the superior end plate of the intact adjacent upper vertebra and the lower end plate of the intact adjacent lower vertebra. The preoperative radiographs were analyzed to measure the thoracolumbar kyphosis. Subsequently the levels of fusion and the level of the osteotomy were determined. The radiographs at the last follow-up were used to evaluate the achieved correction of the thoracolumbar kyphosis. The correction at the single-level osteotomy site was also measured and expressed as a percentage of the total correction. In addition, follow-up radiographs were evaluated for potential loss of correction with time, pseudarthrosis, and screw breakage. The clinical and radiological conditions of those included patients were discussed with them and their relatives and they agreed for the modality of surgery.

Surgical technique used in this study was the same described by Bridwell et al,[3] All patients had long segment fixation points (2 levels above and below the osteotomy level) using pedicle screws and rods and cross links were used in only 3 patients according to surgeon preference. The osteotomy was completed with high speed electric drill, and caution was taken during drilling the most anterior and lateral parts. Intraoperative imaging was used to review the extent of anterior drilling and to assess the angle of wedge osteotomy as planned preoperatively. At the reduction phase, a wake-up test was routinely done to assess the neurological state and power in both lower limbs. Patients were allowed out of the bed on the night of first postoperative day, suction drains were removed after 48 hours, and usually patients were discharged on day 3 postoperative.

Early postoperative CT scan was performed to rule out early postoperative complication. Patients were followed then clinically and radiologically through a period of ≥18 months with a mean of 24.08±6.89 months (ranging from 18 to 36 months). All intraoperative complications and clinical state postoperatively were collected and reviewed.

Software (SPSS, Version 20.0 for Windows, SPSS Inc, Chicago, IL) was used for analyzes of the data. Qualitative variables were summarized as frequency and percentages while quantitative data as mean ±SD. Wilcoxon (non-parametric) test was applied for the comparison of quantitative variables before and after operation. Correlations among variables were studied by using the spearman correlation. AP value <0.05 was considered statistically significant (*) while > 0.05 statistically insignificant.

Results

PSO was done in twelve patients. Table 1, shows that 66.7% of them were males and 33.3% were females who included in the study with mean age 31.25±9.4 months (ranging from 18y to 48y).

According to Visual Analogue Scale (Table 2) preoperative pain was 7.0 with IQR (6.13 - 7.5). There was an improvement in pain postoperatively to 2.0 with IQR (1.0 - 2.0) which is statistically significant (P=0.002). Disability as reported has a 7.0 with IQR (6.0 - 8.0) that improved significantly to 2.0 and IQR (1.25 - 3.0) which is statistically significant (P=0.003). There was no neurological complication in our

study, and three patients with preoperative neurological problems showed variable degrees of improvement accordingly. Also no serious operative or postoperative complication had occurred, and only one case with incidental durotomy that was repaired, also one case with superficial wound infection was treated conservatively.

The Preoperatively kyphotic angle of 37.0° with IQR (28.25° - 43.50°) improved after PSO surgery (Table 2, Figure 1, 2) to 6.0° with IQR (3.25° - 10.25°) which is statistically significant (P=0.002).

There was significant correlation (Table 3) between improvement of pain and disability (P=0.001), while there was no correlation between degree of improvement of pain and the correction degree (P=0.61). There was insignificant difference (improvement) with satisfaction (P=0.11).

Table 1. Distribution of the Studied Patients Group**.**

Variable		N=(12)
Age/y	Mean±SD Range	31.25±9.39 18-48
Sex	Male Female	8(66.7%) 4(33.3%)
Follow-up	Mean±SD Range	24.08±6.89 18-36
Correction	Mean±SD Range	30.17±9.2 18-45
Satisfaction	Excellent Good Fair	10(83.3) 1(8.3) 1(8.3)

Table 3. Correlation between Pain Difference after Operation and Correction, Disability Difference and Satisfaction

Pain difference	Correlation Coefficient	P value
Correction degree	0.16	0.61
Disability difference	0.81	0.001*
Satisfaction	0.48	0.11

Table 2. Comparison of Angle, Pain and Disability Pre and Post-Operatively.

Parameters	Pre-operative			Post-operative			Wilcoxon test	P value
	Mean±SD	Median	IQR	Mean±SD	Median	IQR		
Angle	36.5±9.73	37.0	28.25-43.50	6.33±4.10	6.0	3.25-10.25	3.06	0.002*
Pain	6.79±1.63	7.0	6.13-7.5	1.58±1.0	2.0	1.0-2.0	3.08	0.002*
Disability	6.58±1.64	7.0	6.0-8.0	2.38±1.37	2.0	1.25-3.0	2.97	0.003*

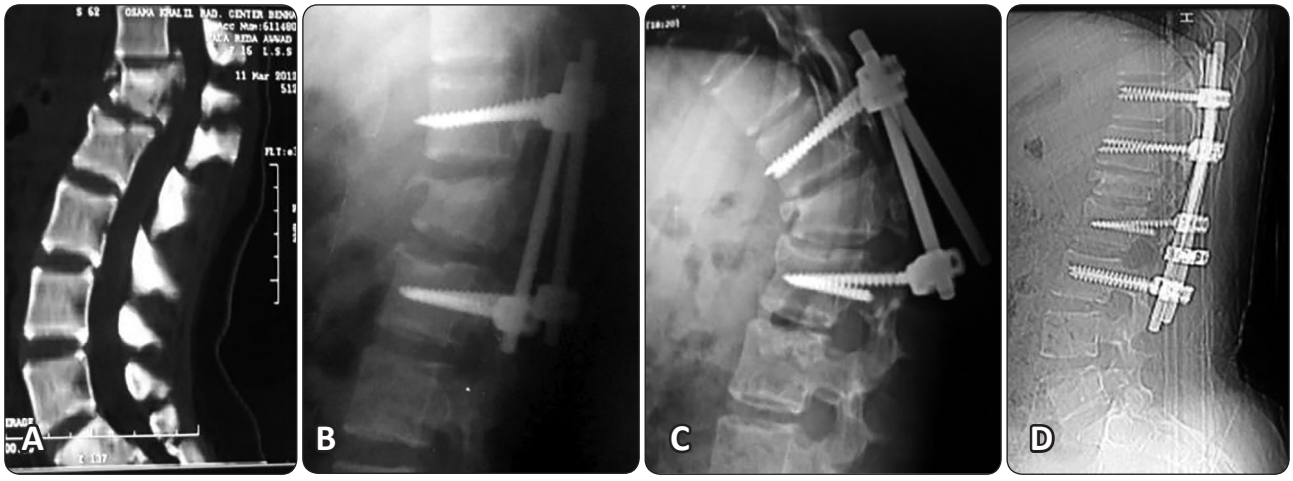

Figure 1. A 21 years old female with L1 burst fracture due to falling from a height as a suicidal attack; (A) initial CT lumbar spine sagittal view, (B) she had primarily short segment instrumentation, (C) six months later, patient with no relief of pain seen with a prominent kyphotic deformity and X-ray showed failed instrumentation with broken screw and an angle of 45 degrees, (D) PSO was done angle was corrected to 3 degrees (long segment without removal of a broken screw) and patient showed satisfactory relief of pain and disability.

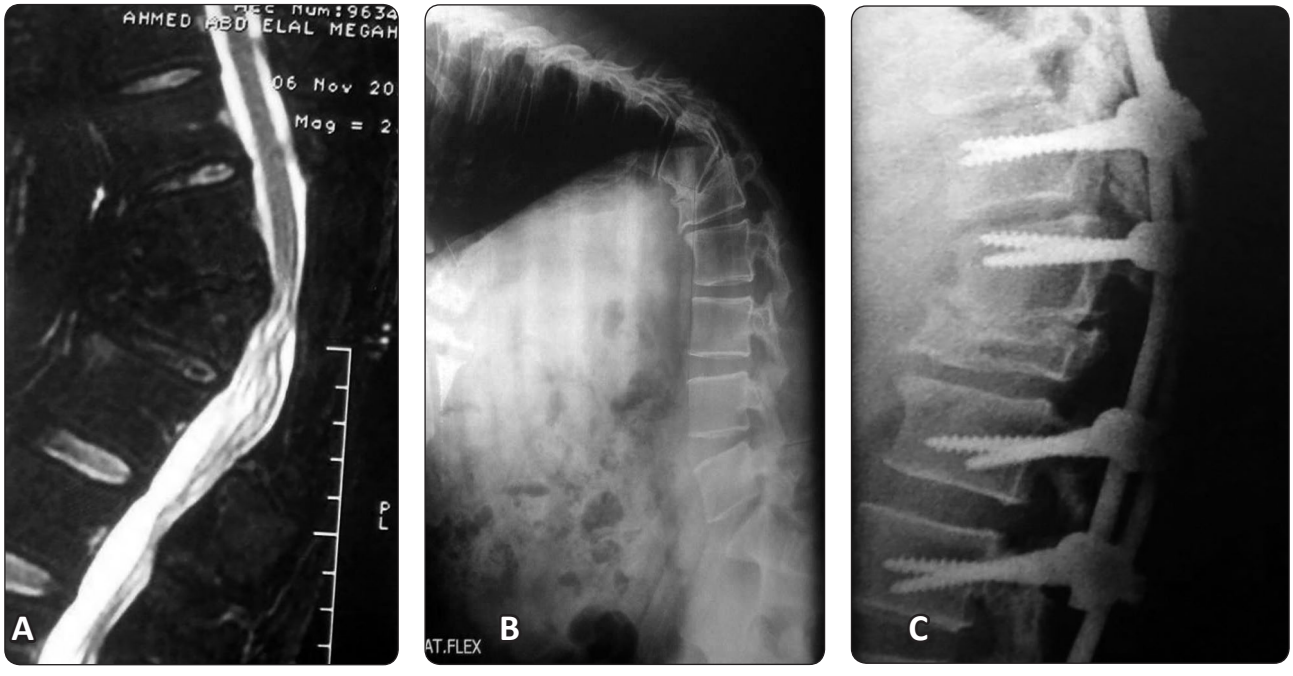

Figure 2. A 43 years old male with road traffic accident; treated initially with decompressive laminectomy without instrumentation, Six years later the patient developed back pain, paraparesthesia, sphincter affection and had a significant kyphotic deformity. (A) T2 weighted MRI dorsolumbar spine sagittal view: a D12 wedge fracture with canal compromise despite posterior decompressive laminectomy, (B) Preoperative plain X-ray lateral view showing 53 degrees angle of deformity in flexion (C) Postoperative X-ray lateral view, correction to 12 degrees was obtained, and patient showed improved back pain, and improved neurological symptoms.

Discussion

Pedicle subtraction osteotomy is a well-known surgical procedure in the management of simple and complex spine deformity.[3,17,20,23] It has been used with other posterior osteotomy techniques such as vertebral column resection (VCR), and Smith-Peterson osteotomy (SPO) in the treatment of symptomatic deformity in thoracic and lumbar spine.[5] Many series were published concerned correction of symptomatic kyphotic deformity that affect the sagittal balance due to many causes, including ankylosing spondylitis, idiopathic scoliosis, degenerative sagittal imbalance, and posttraumatic kyphosis.[4] Recently other authors[8,9,11,26,27] had concentrated on the PSO in treatment of posttraumatic kyphosis publishing their encouraging results in this field favoring it as a primary treatment. Also, a comparison between anterior approach and PSO showed superiority of PSO as regard mean correction angel, loss of correction on follow-up, easy mobilization and better correction after facets resection, especially if fused.[9] The kyphosis deformity following older thoracolumbar vertebral fracture is often caused by inappropriate use of conservative treatment, inadequate immobilization, too early weight-bearing, incorrect surgical procedure and fixation, and improper choice of internal fixation devices.[21,24]

This study included four patients with delayed kyphosis following inappropriate conservative treatment, three with inadequate surgical procedure (decompressive laminectomy without instrumentation), four with failed or inadequate instrumentation, and one who had old healed fracture but newly developed pain. In kyphosis deformity caused by old thoracolumbar vertebral fracture, the abnormal apical region may result in intractable pain or fatigue aggravated when patients are standing or sitting and relieved when patients are lying down. This may be because adjacent levels of apical vertebra bear greater stress due to compensatory lordosis; this stress readily leads to surrounding muscle and ligament strain. Severe compensatory lumbar lordosis and the stress on facet joints cause low back pain; the increased vertebral slippage caused by kyphosis compression of the spinal cord caused by the kyphotic vertebral body, degenerative discs, hypertrophic ligaments, and kyphosis stretching the spinal cord may result in symptoms of spinal nerve and sphincter dysfunction.[7]

The osteotomy should not exceed 30–40 degrees to be safe range of single segment osteotomy; otherwise, the spinal cord is excessively shortened and distorted.[14] Zhang et al,[27] used modified closing wedge osteotomy and obtained mean correction angle of 42°. A correction angle within 45° is considered to be safe.[8] Robert et al,[20] used PSO to obtain an average correction angle of 51° without postoperative complications. PSO can obtain a maximum correction angle of 60°.[25] Yong et al,[26] concluded that a correction angle of 55° was safe when PSO was individualized according to the Cobb angle, spinal stenosis, and compression source. The correction angle can be increased by removing more lamina and upper and/or lower end plate.[10]

In our study, we had correction angles ranging from 18° to 45°, with average correction angle 31 degrees. All patients in early and late follow up showed improved clinical state and thus PSO is considered a safe procedure for correction of kyphotic deformity up to 45°. In four of our patients with more than 35° correction a wide decompression with above and below partial laminectomy to compensate for the buckled thecal sac at stage of reduction was done, these patients had osteotomy level at D 12 and L 1

that is opposing the conus area of the cord. As with all patients, awakening test was performed after reduction to assess the nervous affection that was negative.

We had no neurologic complication reported in our study despite that we did not use intraoperative neuro-monitoring and we depend on awakening test. The reported rates in literature ranged from 0% to 20 %.[1,15] These reports included other indication for use of PSO, and a more complex kyphotic and scoliotic deformities were accomplished. PSO in posttraumatic kyphotic correction showed no neurologic complication in many series.[9,11,12,26] The construct used in our study with 4 screws above and below the osteotomy level led to stability of the instrumented vertebrae, and adding the cross links to the construct added no benefits, as all cases showed good fusion with no pseudoarthrosis.

Conclusion

Symptomatic posttraumatic kyphosis could be safely approached via a posterior pedicle subtraction osteotomy technique, a single set with very satisfactory correction of deformity (up to 45°), and adequate decompression, beside alleviating patient's pain and disability with little or no added morbidity.

References

1. Been HD, Poolman RW, Ubags LH: Clinical outcome and radiographic results after surgical treatment of post-traumatic thoracolumbar kyphosis. Eur Spine J 13:101–107, 2004
2. Bolesta MJ, Bohlmann HH: Late sequel of thoracolumbar fractures and fracture-dislocations, in Frymoyer JW (ed): The Adult Spine Principles and Practice. New York: Raven Press, 1991, pp 1331–1352
3. Bridwell KH, Lewis SJ, Rinella A, Lenke LG, Baldus C, Blanke K: Pedicle subtraction osteotomy for the treatment of fixed sagittal imbalance: Surgical technique. J Bone Joint Surg Am 86:44–50, 2004
4. Bridwell KH: Causes of sagittal imbalance and assessment of the extent of needed correction. AAOS Instr Course Lect 55:567-575, 2006
5. Bridwell KH: Decision Making Regarding Smith-Petersen vs. Pedicle Subtraction Osteotomy vs. Vertebral Column Resection for Spinal Deformity. Spine 31(Suppl 19):171–178, 2006
6. Buchowski JM, Kuhns CA, Bridwell KH, Lenke LG: Surgical management of posttraumatic thoracolumbar kyphosis. Spine J 8:666–677, 2008
7. Chen Z, Dang G, Guo Z, Ji L, Qi Q: Influence of solid thoracolumbar kyphosis on lumbar spine and surgical treatment. Zhong Hua Wai Ke Za Zhi 38:824–826, 2000
8. Chen Z, Li W, Guo Z, Qi Q, Dang GT: Surgical correction of post-traumatic kyphosis of thoracolumbar spine. Zhong Hua Wai Ke Za Zhi 43:201–204, 2005
9. El-Sharkawi MM, Koptan WM, El-Miligui YH, Said GZ: Comparison between pedicle subtraction osteotomy and anterior corpectomy and plating for correcting post-traumatic kyphosis: a multicenter study. Eur Spine J 20:1434-1440, 2011
10. Fang L, Sagi HC, Liu B, Yuan HA: Comparative evaluation of single-level closing wedge vertebral osteotomies for the correction of fixed kyphotic deformity of the lumbar spine. Spine 26:2385–2391, 2001
11. Farzad OK, Ebrahim GH, Mohamed HE, Amir RK, Hosein H: Posterior Surgery Alone in the Treatment of Post-traumatic Kyphosis by Posterior Column Osteotomy, Spondylodesis, Instrumentation, and

Vertebroplasty. Asian Spine J 7(4):260-266, 2013

12. Faundez A, Byrne F, Sylvestre C, Lafage V, Cogniet A, Le Huec JC: Pedicle subtraction osteotomy in the thoracic spine and thoracomlumbar junction: a retrospective series of 28 cases. Eur Spine J 24(Suppl 1):42-48, 2015
13. Gertzbein SD, Harris MB: Wedge osteotomy for the correction of post traumatic kyphosis: A new technique and a report of three cases. Spine 17:374-379, 1992
14. Gertzbein SD: Scoliosis research society: multicenter spine fracture study. Spine 17:528–540, 1992
15. Heary RF, Bono CM: Pedicle osteotomy in the treatment of chronic, posttraumatic kyphotic deformity. J Neurosurg Spine 5:1–8, 2006
16. Knop C, Fabian HF, Bastian L, Blauth M: Late results of thoracolumbar fractures after posterior instrumentation and transpedicular bone grafting. Spine 26:88–99, 2001
17. Lehmer SM, Keppler L, Biscup RS, Enker P, Miller SD, Steffee AD: Posterior transvertebral osteotomy for adult thoracolumbar kyphosis. Spine 19:2060–2067, 1994
18. Magerl F, Aebi M, Gertzbein SD, Harms J, Nazarian S: A comprehensive classification of thoracic and lumbar injuries. Eur Spine J 3:184–201, 1994
19. Malcolm BW, Bradford DS, Winter RB, Chou SN: Post-traumatic kyphosis. J Bone Joint Surg Am 63:891–899, 1981
20. Roberson JS, Whitesides TE: Surgical reconstruction of late posttraumatic thoracolumbar kyphosis. Spine 10:307–312, 1985
21. Schoenfeld AJ, Wood KB, Fisher CF, Fehlings M, Oner FC, Bouchard K, et al: Posttraumatic kyphosis: current state of diagnosis and treatment. J Spinal Disord Tech 23:1–7, 2010
22. Shen WJ, Liu TJ, Shen YS: Nonoperative treatment versus posterior fixation for thoracolumbar junction burst fractures without neurological deficit. Spine 26:1038–1045, 2001
23. Thomasen E: Vertebral osteotomy for correction of kyphosis in ankylosing spondylitis. Clin Orthop Relat Res 194:142–152, 1985
24. Vaccaro AR, Silber JS: Post-traumatic spinal deformity. Spine 26:S111–S118, 2001
25. Wu SS, Hwa SY, Lin LC, Pai WM, Chen PQ, Au MK: Management of rigid post-traumatic kyphosis. Spine 21:2260–2266, 1996
26. Yong-Ming Xi, Min Pan, Zhao-Jie Wang, Guo-Qing Zhang, Ren Shan, Yong-Jun Liu, et al: Correction of post-traumatic thoracolumbar kyphosis using pedicle subtraction osteotomy. Eur J Orthop Surg Traumatol 23(Suppl 1):59–66, 2013
27. Zhang X, Zhang X, Zhang Y, Wang Z, Wang Y: Modified posterior closing wedge osteotomy for the treatment of posttraumatic choracolumbar kyphosis. J Trauma 71:209–216, 2011

Address reprint request to:

Mohamed M Elmaghrabi, MD.
Department of Neurosurgery, Benha University, Benha, Egypt.
Email: Dr_elmaghrabi@yahoo.com

الملخص العربي

الطرح العظمي للعنيق في علاج حدب ما بعد الكسر

البيانات الخلفية: يعد الحدب ما بعد الكسر واحد من أسوء مشاكل كسر العمود الفقري بجانب آلام السرير والعجز مما قد يؤدى الى ظهور أعراض عصبية جديدة والتدخل الجراحى، وذلك ما يجعله تحدى صعب.

الغرض: تهدف الدراسة لتقييم أسلوب جراحة طرح عظمي للعنيق كاجراء جراحى خلفى وحيد في علاج حدب ما بعد الكسر.

تصميم الدراسة: تم اجراء دراسة اكلنيكية مستقبلية على اثنى عشر مريض (ثمانية رجال وأربعة سيدات وكان متوسط السن 31.25 ± 9.39 سنة) يعانون من أعراض حدب ما بعد الكسر وتم اجراء الجراحة لهم في قسم جراحة المخ والأعصاب بجامعة بنها، ثم تم تقييم النتائج بعد متابعة المرضي خلال الفترة من شهر فبراير 2013م الي شهر ابريل 2015م.

المرضي والطرق: تم تحليل النتائج قبل وبعد الجراحة باستخدام مقياس للألم والعجز ودرجة اصلاح زاوية الحدب. كما تم تحليل أي مضاعفات، نتائج الأشعات ورضا المريض من نتيجة الجراحة.

النتائج: وقد أظهرت النتائج، بعد متابعة المرضي لحوالي ثمانية عشر شهر، نجاح احصائي لاصلاح زاوية الحدب من (28.25 - 43.5 درجة) الي (3.25 - 10.25 درجة) ، كما أوضحت النتائج نجاح احصائي في مقياس الألم من (6.13 – 7.5) الي (1 – 2) وأيضا مقياس العجز من (6 – 8) الي (1.25 – 3). لم تظهر أى مشاكل عصبية للمرضى بينما أظهرت استجابة 91.6% من المرضي باحساس الرضا من نتيجة الجراحة.

الاستنتاج: أثبتت الدراسة أن الطرح العظمي للعنيق تعتبر طريقة آمنة وفعالة لعلاج حدب ما بعد الكسر ، مع الحصول علي نتيجة مرضية جدا. وقد وجدنا بدراستنا امكانية الحصول على اصلاح لزاوية الحدب الى 45 درجة بآمان بدون أي مضاعفات.