Clinical Article

Online ISSN : 2314-8969
Print ISSN: 2314-8950
www.esa.org.eg

Egy Spine J 15:15-23, 2015

SIMULTANEOUS VIDEO-ASSISTED THORACOSCOPIC DEBRIDEMENT/ FUSION AND PERCUTANEOUS TRANSPEDICULAR INSTRUMENTATION IN PRONE POSITION FOR THORACIC AND THORACOLUMBAR INFECTIONS

Simultaneous Video-Assisted Thoracoscopic Debridement/ Fusion and Percutaneous Transpedicular Instrumentation in Prone Position for Thoracic and Thoracolumbar Infections

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Received at:
November 18th, 2014
Accepted at:
June 7th, 2015

Abstract

Background Data: with increased life expectancy, the incidence of spinal infections in elderly with debilitating disease is rising. The traditional operative therapy in this age group has several morbidities and increased mortality rate. The usage of minimally invasive surgeries in these patients give promising results to overcome or reduces those morbidities and to avoid devastating surgical complications.

Study Design: A prospective observational study.

Purpose: was to determine whether the combination of video- assisted thoracoscopic debridement and reconstruction with posterior percutaneous transpedicular instrumentation in prone position achieves treatment goals in thoracic and thoracolumbar spinal infections and minimizes the associated morbidities.

Patients and Methods: Between May 2010 and May 2013, 61 consecutive patients with spinal infections at the thoracic and thoracolumbar junction were operated upon in our hospital. Those patients underwent anterior thoracoscopically assisted debridement and fusion plus posterior percutaneous stabilization in prone position. The clinical and radiological assessments of these patients were evaluated preoperatively and postoperatively with mean follow up of 37.7 months. The clinical outcomes data were assessed postoperatively and final follow-up by use of VAS and subjective clinical results. Plain X-ray in two views was used for the radiological outcome evaluation.

Results: Sixty one patients were included (38 males and 23 females) with mean age of 67.5 years, 78% were older than 60 years. More than 80% of the patients had associated comorbidities. The mean operative time was 195.49 ± 41.60 minutes, for thoracoscopic anterior surgery was 100.57 ±29.14, and for posterior surgery was 94.92 ± 28.35 minutes. The average blood loss was 597.54 ml. Thirty two patients (52%) had preoperative neurological deficits ranging from Frankel A to D. One patient (Frankel A) did not show any neurological improvement at the final follow-up. The mean VAS at final follow-up was 1.03/10 (preoperative 7.89). The mean preoperative kyphosis angle was 17.11°, improved to 6.51°postoperatively and reached 8.48° at the final follow-up. First year mortality rate was 6.5% (4 patients).

Conclusion: Minimal invasive spinal techniques including thoracoscopic debridement and fusion and posterior percutaneous instrumentation showed good clinical and radiological outcomes and can be considered as alternative to open procedures with decreased rates of morbidities in managing thoracic and thoracolumbar infections in elderly patients. (2014ESJ074)

Keywords: Spinal infections; surgical treatment; VATS; thoracoscopic; percutaneous instrumentation

Introduction

The incidence of vertebral osteomyelitis is reported to range between 2-7% of all cases of bone infection.[33] It is age-related and has been on the rise over last decades.[14] Thus, it occurs frequently in elderly and debilitated patients who have significant medical comorbidities and predisposing factors for spinal infection.[5] The thoracic spine and thoracolumbar junction are areas frequently involved in various types of spinal infections.

Many uncomplicated cases may be successfully treated non-surgically by spinal immobilization and antibiotics.[7] In multi-morbid patients however, nature´s potential for accessing and eradicating an infected focus is limited, patient´s compliance might be lacking and thus conservative treatment often fails. Therapeutic concepts of vertebral osteomyelitis are evolving, and spinal surgery is increasingly important treatment measure.[11]

The aim of surgery in is to relieve pain by eradication of the infection, reconstruction of the defects and re-stabilization of the spine. Anterior radical debridement and spinal fusion is advocated as an effective treatment of these infections.[9,34] Video assisted thoracoscopic surgery (VATS), in cases of thoracic and thoracolumbar spinal infection, is a good alternative to conventional thoracotomy with minimal morbidity, although surgically demanding.[26]

There are few reports in the literature of VATS performed on prone patients. This study analyses prospectively 61 patients, who were operated upon for thoracic or thoracolumbar spinal infection in our hospital, between May 2010 and May 2013, using VATS combined with percutaneous fixation in all patients while the patient positioned prone.

Patients and Methods

Written informed consent was obtained from each patient and possible conversion to open thoracotomy. All patients were preoperatively (preop) assessed clinically and neurologically as per Frankel grading. X-rays of the affected spinal region and whole spine MRI were obtained in all the cases. Routine laboratory investigations included inflammatory parameters ESR, CRP, leucocytes and Procalcitonin (PCT) in cases of septicaemia.

Perioperative (periop) measurements included operative time, blood loss, chest tube drainage, postoperative (postop) pain using visual analogue scale (VAS), length of hospital stay and complications. The clinical data were assessed preoperative, at 3,6,12 months and at the last follow up using subjective clinical results.[6]

Operative Technique:

After general anaesthesia using a single-lumen endotracheal tube, the patient is turned in the prone position. Sterilization and draping are done taking care that the anterior axillary line is in the sterile area on the side where the approach will be done. For graft harvesting, the iliac crest should be accessible. Iliac bone graft is taken percutaneously in cases of intersomatic fusion or open technique in patients with large defects.

Thoracoscopic Procedure:

The technique included two incisions: the first is about 2.5 cm mini-thoracotomy done in the mid-axillary line and the second is about 1 cm in the posterior axillary line for the 30° thoracoscope.

Cooperation with the anaesthetist to momentary deflate the lung during the first few minutes of the approach is mandatory.[2,4] The aimed level is determined and checked radiographically. The pre-vertebral parietal pleura is incised and pealed using a blunt ball-tipped hooked dissector. Usually for lesions cranial to T9, the right side was approached and left side for levels below. For optimal placement of the retractor minimal disinsertion of the spinal attachment of diaphragm can be done to expose the segment L1/2.[1,31] The segmental vessels can be identified, ligated and cut if necessary. A thorough debridement was performed to remove necrotic disc, sequestra, infected granulation tissue as well as abscess drainage if present under direct vision through the thoracoscope. Spinal canal decompression was done in 36 patients (59%). Due to personal experience of failures with structural grafts, anterior column reconstruction is performed using a titanium cage filled with iliac bone graft. Interbody fusion cage sufficed in 49 patients (80%) and expandable one to bridge corpectomy defect was necessary in 12 patients. At the end of the operation, the pre-vertebral pleura is closed, the thoracic cavity is inspected and an intercostal tube is inserted. The percutaneous posterior instrumentation is then started after closure of the anterior approach under sterile conditions.

Posterior Percutaneous Instrumentation:

Pedicle screws were placed under 2 image intensifiers. At the target pedicle, the skin is incised and the fascia is opened. Under image intensifier, a cannulated pedicle finder is inserted through the pedicle. Once the tip of the cannulated finder has been advanced into the anteromedial portion of the vertebral body, the stylet of the finder is removed and replaced by a guide wire. The cannulated polyaxial screw is then inserted along the guide wire after removal of the pedicle finder. After insertion of all screws using the same technique, the position of them is checked using the C-arm in both anteroposterior and lateral views.

The extent of posterior instrumentation depends on bone quality of the patient, degree of preoperative deformity and the technique done anteriorly. Then the rods are applied percutaneously through the incision for the uppermost screw of the instrumentation and tightened via the screw-extensions in corrective compression when needed. The incisions are then closed and adhesive strips are then applied.

Postoperative Care:

Broad spectrum antibiotic was given till the results of the culture and sensitivity test. Inflammatory parameters (CRP, ESR and WBC) were monitored carefully at regular intervals. The chest tube was removed average at the 4th day after the surgery.

The modified Brantigan–Steffee classification[3] was used to evaluate the fusion at 3, 6,12 months and the final follow-up, these criteria include the denser and more mature bone in fusion area than originally achieved during surgery, no interspace between the cage and the vertebral body, and mature bony trabeculae bridging in fusion area.

Results

The study included 61 patients (38 males and 23 females), mean age of 67.5 years (range 43-85). The mean follow up was 37.7 months (13.9-66.2). More than 80 % of the patients (49 patients) had comorbidities, cardiac diseases in 33 (54 %), pulmonary diseases in 24 (39%), Diabetes Mellitus in 25 patients (41%). According to the American Society of Anesthesia (ASA) scoring system, 43% of the patients had (ASA) score of III and IV. Back pain was present in all patients, fever in 21 (34%) and neurological deficit in 31 patients (52%). The mean duration of back pain was 50 days (range 7-120). The most common site of involvement was the thoracolumbar region (Th10/11-L1/2) in 33 patients (54%) followed by mid-thoracic region (Th6/7-Th9) in 18, and less in the high thoracic (Th2/3-Th6) only in 10 patients. Multifocal spinal infection was detected in the whole spine MRI in 9 cases (15%). Elevated inflammatory parameters were elevated at the time of admission in 54 patients (89%) with mean CRP of 100.7 mg/L, ESR of 81 mm/L and total leucocyte count of 9.9 X10^3/mm.^{3} (Table 1)

A left-sided approach was used in 37 patients and a right in 24. The mean total operative time was 195.49±41.60 min; for anterior surgery was 100.11±29.14 min; and for posterior 94.92±28.35

min. The mean total blood loss was 542 ml. There was significant time difference in cases with and those without spinal canal decompression (P-value of 0.011) and between blood loss in both group (P-value of 0.00). The mean IMC-stay was 5.65±3.470 days. The chest tube was removed on average 4 days (range 3–6 days) after surgery. Staphylococcus aureus was the most common isolated organism in 25 patients (41%) and in 37% no organism could be isolated. The mean postop hospital stay was 17±5.525 days. The antibiotic therapy ranged between 1.5 and 3 months.

According to Huang classification of complications in thoracoscopic surgeries,[13] perioperative complications occurred in 4 patients (6%). Grade III and IV complication not reported in any of our patients. (Table 2) One patient was re-operated within the first three months (extension of percutaneous fixation) due to increased kyphosis due to adjacent osteoporotic fracture. Another patient had to be operated (the same technique from the other side) due to spondylodiscitis in adjacent segment within 13 months.

Clinical Outcomes:

Mortality rate in the first year was 6.5% (4 patients); three during the hospital stay (two due to sepsis and one due to cardiac infarct), one died after 6 months after discharge due to renal failure. For subjective patient reported outcomes at the last follow up for 58 patients 97% of patients had satisfactory results i.e. good or excellent result, excellent results were obtained in 30 patients, good in 26, fair in 2 patients. The mean VAS improved from 7.89 preoperative to 1.03 at the last follow up, mean preoperative Kyphotic angle was 17.11° improved to 6.51° postop and reached 8.48° at the last follow up. (Table 3) Based on the Frankel grading, all patients improved at least one level except one patient with Frankel A, who remained unimproved till the last follow up. (Table 4)

According to modified Brantigan–Steffee classification, no cases of instrumentation failure till the last follow up reached. Full bony fusion in the x-ray (grade 5 fusion) reached in the last follow up in 56 of 57 patients (98%). (Table 5)

Table 1. Means of the Preoperative and Postopeative Inflammatory Parameters.

Parameters	Pre-operative	2 Weeks Post-operative	Last Follow-up
CRP	100.7	40.7	12.1
ESR	81	67.4	35.8
WCC	9.9	8.1	7.7

WCC: white cell count

Table 2. Perioperative Complications According to Huang Classification and their Management.

Complication	Grade	Patients No.	Management
Aspiration pneumonia	IIa	1	Conservative
Recurrent Effusion	IIa	1	Chest tube
Subcutaneous hematoma	I	1	Drainage
Sphincter dysfunction	I	1	Conservative

Table 3. Means of Preoperative and Postoperative VAS/ Kyphosis Angle.

Parameters	Pre-operative	Post-operative / 3 months	Final Follow-up
VAS (/10)	7.89	1.93	1.03
Kyphotic angle°	17.11°	6.51°	8.48°

Table 4. Distribution of the Patients According Frankel Grading.

Frankel Grade	Pre-operative	Post-operative / 3 months	Last follow-up
A	1	1	1
B	1		
C	10	3	
D	20	16	14
E	29	38	42
Total	61	58	57

Table 5. Distribution of Patients According to Fusion Grade (Brantigan-Steffee)

Brantigan Steffee	3 months	6 months	12 months	Last Follow-up
I				
II				
III	21	8	1	
IV	16	13	7	1
V	21 (36%)	37 (64%)	49 (86%)	56 (98%)
Total	58	58	57	57

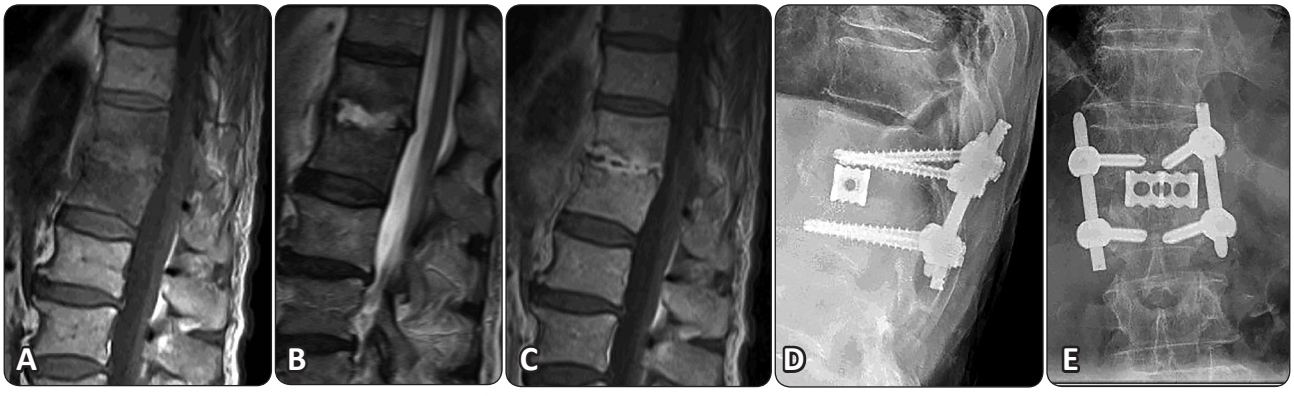

Figure 1. Preoperative MRI sagittal Images of Spondylodiscitis Th11/12 (A) T1 sequence (B) T2 Sequence (C) T1 with contrast injection. Postoperative AP (D) and lateral (E) radiographs one year postoperative.

Discussion

VATS:

Historically, spine infections were devasting diseases with exceedingly high morbidity and mortality rates. With the advent of new diagnostic techniques, multiple-drug antimicrobial chemotherapy, and improvements in surgical techniques, the prognosis has improved dramatically in recent years.[26] The most widely accepted approach for surgical management of vertebral osteomyelitis combines an anterior debridement and autologenous bone grafting with posterior instrumentation stabilization performed in a single- or two-stage procedure.Video-assisted thoracoscopic spinal surgery began in the 1990s and has gained popularity.[26] Accompanying this has been a dramatic shift in our thought process, encouraging the philosophy of minimally invasive spinal surgery, both anteriorly and posteriorly.[21] The primary goals of minimally invasive techniques focus on reducing the operative morbidity associated with classic open surgical techniques. Landreneau et al. compared in 1993 VATS versus thoracotomy to accomplish pulmonary resection and concluded that VATS is associated with reduced pain, shoulder dysfunction, and early pulmonary impairment compared with

lateral thoracotomy.[19] In 1995 Regan et al applied the VATS technique to adress different spinal pathologies and concluded the same advantages. Five years later, Huang et al published the data of ten patients undergoing VATS for the treatment of spinal tuberculosis involving levels from T5 to T11. They reported a mean operative time of 174 mns and a mean blood loss of 485 ml. Similarily, Kapoor et al performed VATS for tubercular spondylitis involving levels from T4 to T9 in 16 patients and achieved similar results (497 ml mean blood loss and 223 mns mean operative time). Later, Lv et al performed also VATS for thoracic spinal tuberculosis in 58 patients and obtained similar figures (230 mns average operative time and 570 ml average blood loss). Although the current study is dealing with non-spedific infections involving levels from T2 to L2, comparable figures were found as regards blood loss (542 ml). The amount of blood loss in all these series – including the current one – is much less than that reported during an open thoracotomy.[16] In a comparative study of two paired series of thoracoscopy versus thoracotomy in spine surgery of 20 patients each, intraoperative blood loss was 447 ml in the thoracoscopy group and 837 ml in the thoracotomy group.[24] The reason is obvious. The latter procedure requires large amounts of muscle to be cut in the „wide funnel exposure“ to gain access to a relatively small area of disease.[16] Ragarding the mean operative time for VATS, this has been reported to be longer than open thoracotomy by many investigators.[16] The cause of the long duration in VATS is the learning curve to develop adequate hand and eye coordination, which is necessary to perform remote bone and soft tissue dissection, and to establish proper orientation under the angled endoscope.[13] Furthermore, the endoscope offers a two- and not a three-dimensional picture, which makes the learning curve also high. In our series, the mean duration of surgery for VATS was 100 mns. This was shorter than in the previously mentioned studies. The cause might be the different nature of the disease. However, the main reason is the use of VATS in our institution since 1996 by the senior author (HB). The first patient in this work was operated in 2010; i.e. fourteen years after the application of VATS – which explains the relative absence of the effect of the learning curve on the operative time.

Technical Notes:

Several technical points are worth mentioning regarding VATS technique in this work. First; although the lateral position is the most widely accepted position for VATS,[10,23,26,29,30,35] all patients in this series were operated in the prone position. This offers several advantages: In the presence of kyphosis, the prone position allows better correction by placing the anterior structures under tension. Simultaneous anterior and posterior surgery is also possible when needed to correct gross kyphotic deformities. Furthermore, blood and disc fragments fall anteriorly away from the spine and could be removed at the end of the procedure.[17] Another advantage is saving time in the operating room due to decreasing the time needed by the anesthesiologists and the transition time between the anterior and posterior procedures.[17,32] The first application of VATS in the prone position was described by McKenna et al in 1995, where they performed VATS simultaneously with laminectomy to resect a mediastinal neurogenic dumbbell tumor.[25] Papin et al,[28] treated eight cases of adolescent scoliosis by anterior thoracoscopic release and posterior instrumentation and fusion. Six of their patients were operated in the prone position. In 2003, Sucato and Elerson published a comparison between the prone and lateral position for performing a thoracoscopic anterior release and fusion for pediatric spinal deformities. They concluded that the prone position is safe, achieves the same results and saves time.[32]

The second technical point is the use of a standard single lumen endotracheal tube. In the contrary, most reports dealing with VATS applied a double-lumen tube to allow selective ventilation to the contralateral lung and collapse of the ipsilateral lung.[10,29,18,27] However, most authors using the prone position used a single lumen tube.[17,32] Gentle rapid low breaths together with a special lung retractor allowed good exposure of the spine. King et al used also a single lumen tube and placed a Veress needle in the pleural space to inflate the space with CO2 to 4 mmHg in order to induce ipsilateral atelectasis before starting the procedure. This step was not necessary in our technique, where the anesthesiologist induces apnea for about two minutes till the lung retractor is applied.

The third technical point is the number of working channels. Most authors published the

use of several portals; mostly three to four.[13,16,17,29] Huang et al,[12] applied VATS in managing tuberculous spondylitis in ten patients. They used a three-portal technique in seven patients and a modified two-portal minithoracotomy technique that required a small incision for the thoracoscope and a larger incision, measuring 5 to 6 cm, for the procedures in three patients. The latter technique is the standard one in our institution with a minithoracotomy of 3 to 5 cms. The advantage of this method is that bigger cages could be inserted to reconstruct big defects after corpectomy. Furthermore, conventional long spinal instruments could be used without limitation.

Percutaneous Instrumentation:

The application of pedicular screws percutaneously leads to the same results as in open surgery with the least amount of tissue destruction and minimal blood loss.[21] Another point of concern in compromised patients suffering from spondylodiscitis is wound healing and postoperative wound infection. Thanks the percutaneous technique, no postop. posterior wound infection occured in this series. Lin et al compared open versus percutaneous pedicle screew fixation in treating pyogenic spondylodiscitis.[20] They proved that percutaneous posterior instrumentation was asociated with significantly less intraop. blood loss, shorter operative time, and reduced postop. pain with no adverse effect on infection control.[20] These findings agree well with those obtained in this work, where the mean operative time for posterior instrumentation was 93 mns and the amount of blood loss during instrumentation was negligeable.

Combined Use of Two Minimally Invasive Techniques:

The rapid expansion of minimally invasive surgery provides promise to redefine treatment options and to determine new surgical standards. Thanks new technology, standard procedures could be performed nowadays in a less invasive fashion. In this work, two minimally invasive techniques; namely VATS for anterior debridement and reconstruction together with percutaneous instrumentaion for posterior stabilisation, were applied in order to offer the immunocompromised patients suffering from spondylodiscitis the advantages of both methods. Kaiser et al mentioned four prerequisits to accept a minimally invasive technique.[15] First, there should be no compromising of the surgical procedure if one wishes to proceed with less invasive approach; the indications for operation should be the same, and what is accomplished by the less invasive procedure should be equivalent to that achieved by the open procedure. Likewise, the incidence of complications should not differ significantly from that which result from from the analogous open procedure. These four criteria were fulfilled in the current study and in no case a shift for open surgery was necessary. Postop. VATS-related complications occurred in four patients. These were simply alterations from the ideal postoperative course resulting in no lasting disability and were classified as grade I and IIa according to Huang et al. Grade III and IV complications were not reported in any of the patients.

Conclusion

Minimal invasive spinal techniques including thoracoscopic debridement and fusion and posterior percutaneous instrumentation showed good clinical and radiological outcomes and can be considered as alternative to open procedures with decreased rates of morbidities in managing thoracic and thoracolumbar infections in elderly patients.

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الملخص العربي

دور منظار الصدر الجراحي وتثبيت الفقرات من خلال الجلد في معالجة حالات الالتهابات الميكروبية بالفقرات الصدرية في نفس وضع البطن

خلفية علمية: مع ازدياد المتوسط العمري، تزداد نسبة حدوث الالتهابات الميكروبية في كبار السن، حيث ينتج عن الجراحات التقليدية مضاعفات عدة وزيادة في نسبة الوفيات في مثل هذه الحالات، وبفضل استخدام الجراحات محدودة التدخل تضاءلت هذه المضاعفات، وتم الحصول على النتائج المرجوة في مثل هذه الحالات.

نظام الدراسة: دراسة مستقبلية .

موضوع الدراسة : تقييم نتائج إقران استخدام منظار الصدر الجراحي مع التثبيت الخلفي للفقرات بواسطة مسامير وقضبان من خلال الجلد في وضع البطن، ودور ذلك في تقليل المضاعفات .

الطـــرق: ما بين مايو ٢٠١٠ – مايو ٢٠١٣ تم معالجة ٦١ مريضاً مصاب بالتهاب ميكروبي بالفقرات الصدرية والصدر قطنية ، وتم إجراء جراحة مكونة من مرحلتين لجميع المرضى في جلسة واحدة: المرحلة الأولى من الأمام باستخدام منظار الصدر الجراحي، ومن الخلف بمسامير من خلال الجلد. تم تقييم جميع المرضى أكلينيكياً وبواسطة الأشعات وكذلك التحاليل المعملية قبل إجراء الجراحة وكذلك التحاليل المعملية قبل إجراء الجراحة ، وكذلك بعدها وحتى نهاية متابعة المريض.

النتائـــج: واحد وستون مريضًا (٣٨ ذكور ، ٢٣ إناث) مع متوسط عمر ٦٧,٥ سنة. متوسط وقت الجراحة ١٠٠ دقيقة للجراحة من الأمام ٩٤ دقيقة للمرحلة الخلفية. متوسط فقد الدم ٥٩٧ مللي متر. حوالي ٥٢٪ من المرضى كان لديهم ضعف بالأعصاب قبل الجراحة ، حدث تحسن في جميع المرضى إلا مريضًا واحدًا لم يطرأ عليه تحسن ، وبلغت نسبة الوفيات في العام الأول بعد الجراحة ٦,٥ ٪ (٤ مرضى).

ملخص الدراسة: الجراحات محدودة التدخل أسفرت عن نتائج مرضية أكلينيكيًا وكذلك بالأشعة، ولذلك تُعد هذه الجراحات بديلاً جيدًا للجراحات المفتوحة في مثل هذه الأمراض وخاصة في المرضى متقدمي العمر.