

ORIGINAL ARTICLE

Assessment of related surgical complications of minimally invasive retropleural approach to the thoraco-lumbar spine[☆]



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Received 23 June 2017; accepted 14 October 2018

KEYWORDS

Retropleural approach;
Thoraco-lumbar spine;
Minimally invasive

Abstract

Objective: To review the complications associated with the minimally invasive retropleural approach used in the anterior approach to the thoraco-lumbar spine.

Material and method: We present the MIS surgical technique and the evaluation of data collected prospectively from the initial series of 31 patients undergoing surgery. Pleural opening during the approach, lung complications derived, other surgical complications, time of intervention, intraoperative bleeding, need for transfusion and hospital stay are evaluated.

Discussion: The mean age of the patients was 58 years, the surgical time 225 min, and the bleeding 274 ml, with a 13% postoperative transfusion. Intraoperatively, pleural opening was detected in 8 cases, of which none had major pulmonary complications during the postoperative period. There were 3 cases of mild pleural effusion, all patients without pleural opening, and one case of haemopneumothorax due to intercostal vessel bleeding that required reoperation. The percentage of intercostal neuralgia was 3%. The mean hospital stay was 6.7 days, and 24 of 31 patients were able to initiate early mobilization on the first postoperative day.

Conclusions: The retropleural approach allows the surgical treatment of pathologies requiring anterior access to the thoraco-lumbar spine, with a low profile of pulmonary complications, and with the advantages of minimally invasive techniques in terms of less bleeding, early recovery and shorter hospital stay. Nevertheless the learning curve is long.

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[☆] Please cite this article as: Bordon G, Burguet Girona S. Evaluación crítica de las complicaciones asociadas al abordaje retropleural mínimamente invasivo en cirugía de columna toracolumbar. Rev Esp Cir Ortop Traumatol. 2019;63:209–216.

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PALABRAS CLAVE

Abordaje retropleural;
Columna toracolumbar;
Cirugía mínimamente invasiva

Evaluación crítica de las complicaciones asociadas al abordaje retropleural mínimamente invasivo en cirugía de columna toracolumbar

Resumen

Objetivo: Revisar las complicaciones asociadas al abordaje retropleural mínimamente invasivo utilizado en el abordaje anterior a la columna toracolumbar.

Material y método: Se presenta la técnica quirúrgica y la evaluación de datos recogidos de manera prospectiva de la serie inicial de 31 pacientes intervenidos. Se evalúa la apertura de pleura durante el abordaje, las complicaciones pulmonares derivadas, otras complicaciones quirúrgicas, el tiempo de intervención, el sangrado intraoperatorio, la necesidad de transfusión y la estancia hospitalaria.

Resultados: La edad media de los pacientes fue de 58 años, el tiempo quirúrgico de 225 min y el sangrado de 274 ml, con un 13% de transfusión en el postoperatorio. De forma intraoperatoria se detectó la apertura de la pleura en 8 casos, de los cuales ninguno tuvo complicaciones mayores pulmonares durante el postoperatorio. Se produjeron 3 casos de derrame pleural leve en pacientes sin apertura de pleura, y un caso de hemo neumotórax por sangrado de vaso intercostal que requirió reintervención. El porcentaje de neuralgia intercostal fue del 3%. La estancia media hospitalaria fue de 6,7 días, y 24 de 31 pacientes pudieron iniciar movilización precoz el primer día postoperatorio.

Conclusiones: El abordaje retropleural permite el tratamiento quirúrgico de patologías que requieren un acceso anterior a la columna toracolumbar, con un perfil bajo de complicaciones pulmonares y con las ventajas de las técnicas mínimamente invasivas en cuanto a menor sangrado, recuperación precoz y menos estancia hospitalaria. Su curva de aprendizaje es larga.

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Introduction

The anterior approach to the thoraco-lumbar segment enables reconstruction of the anterior wall in cases of vertebral fracture, metastasis and inflammatory injuries.^{1,2} It is also used for decompression of the medullary canal and correction of deformities in cases where the posterior approach alone would not be sufficient.³⁻⁷

The percentage of complications associated with the classical approach using thoracotomy in the literature is found to be around 40%–50%,^{3,5,8} with specifically pulmonary complications accounting for up to 64% in some series.⁹

With the boom of minimally invasive techniques (MIS) as alternatives to standard approaches, thoracoscopy has acquired a major significance, due to the reduction of morbidity in contrast to the extensive incision-dissection used in thoracotomy. The thoroscopic approach is associated with lower bleeding, less postoperative pain and early post surgical recovery.^{1,10,11} However, it is still a transthoracic approach, with possible associated pulmonary complications because the approach thresholds invade the pleural cavity.^{1,10}

The first retropleural approach was described by McCormick¹² in the 1990s for observation of the anterolateral spine without the need to enter the pleural cavity and therefore in theory, reducing pulmonary morbidity associated with thoracotomy. The retropleural approach in its minimally invasive mode combines the advantages of the MIS techniques (regarding bleeding, early recovery, hospital stay time...) with fewer pulmonary complications and the preservation of the pleura intact.^{2,3,6,7} Its use is not

extensive, as shown by the low quantity of publications in recent years.

The aim of this study is to review the complications associated with the minimally invasive retropleural approach in patients who underwent surgery in our hospital, with particular emphasis on pulmonary complications, to assess the safety of this surgical technique.

Material and method

Between January 2012 and June 2016, 31 patients underwent surgery in our hospital with the MIS retropleural approach. Prospective recording in all patients was made of time in surgery; intraoperative bleeding; pleural opening during the approach and other intraoperative complications. During hospitalization the following were recorded: pulmonary complications; non pulmonary complications; the need for transfusion and hospital stay. During follow-up the following were recorded: complications and the need for further surgery due to causes relating to the approach. The patients were reviewed in external surgeries after 6 weeks, 3 months, 6 months, one year and 2 years.

A retrospective review of data obtained prospectively was carried out.

Description of the surgical technique

Surgery was performed under general anaesthesia with selective pulmonary intubation for posterior lung collapse, if required. Generally a left-sided approach was

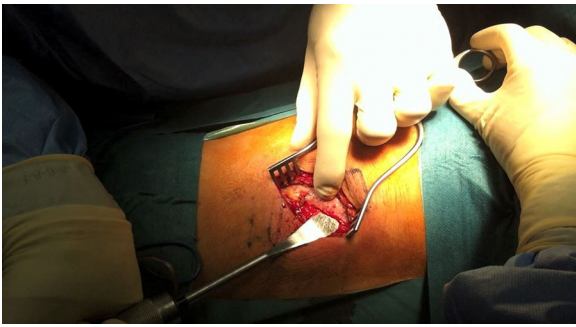


Figure 1 Detachment from the periosteum of the fragment of rib to be resected depending on skin marking.

preferred as vascular status was more favourable, close to the aorta instead of the azygos venous system. The left-sided approach also allows for better mobilization of the diaphragm, which is hindered by the liver in a right-sided approach. For the left-sided approach the patient is in right lateral decubitus position. The correct lateral position of the patient's spine must be confirmed under scopic observation since in the case of obliquity there is an increased risk of invading the medullary canal or causing damage to the large blood vessels when manipulating the disc and the vertebral body.

After identifying skin level and marking with scopic assistance, an incision of 5–7 cm was made on the disc to be approached by following the direction of the rib. The underlying muscle mass was separated and the rib was carefully detached from the periosteum so as not to damage the vessel bundle, with the periosteum continuing to be attached to the pleura (Fig. 1). Osteotomy of the rib was then performed, resecting a fragment of 4–5 cm. Retropleural dissection was performed generally with the lung collapsed, patient characteristics permitting. If not, this is not necessary. This facilitates dissection of the soft tissues and separation from the parietal pleura of the endothoracic fascia from the posterior region of the costal osteotomy to the thoracic spine (Fig. 2).

To create space to access the disc and the vertebral bodies, the parietal pleura was separated from the lung using a pneumatic separator with valves anchored to the operating table (Unitrac®, Aesculap B-Braun). The spine was accessed at thoraco-lumbar level between the fibres of the psoas muscle separating the diaphragm inferiorly and at times the diaphragm cross should be slightly divided if we wished to extend the approach to further inferior levels (L1–L2).

With this approach bipolar forceps may be used to coagulate the segmental arteries if required in the case of corpectomy. A surgical microscope may also be used and implants may be inserted as a replacement for the vertebral body or screwed plates, without the need to extend the incision.

Following surgery, the separator must be carefully removed so as to avoid damaging the pleura. Physiological serum is used to confirm that there are no leakages and a drain is inserted.

If pleural opening is observed a thoracic tube for pleural drainage is inserted which is removed after 48 h if the control chest X-ray is appropriate. Should a minimal opening appear or the opening may not be sutured, only a drain is inserted.

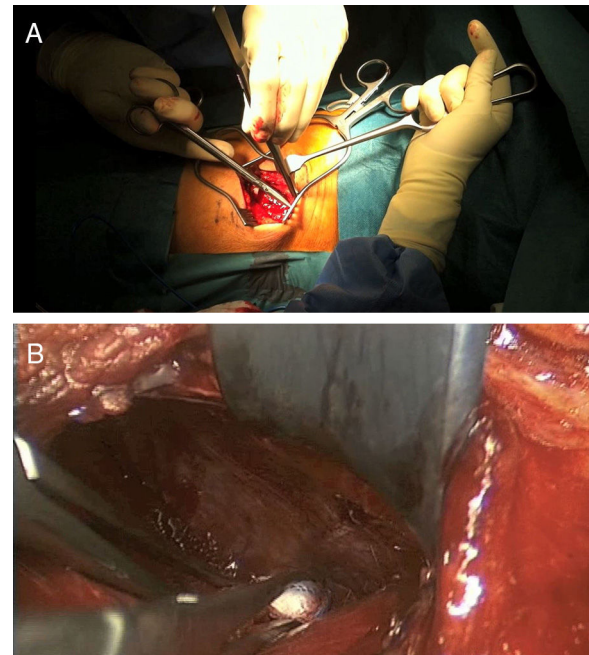


Figure 2 (A, B) Careful dissection for separation from the parietal and visceral pleura for retropleural approach.

During the post-operative period the patient is encouraged to start sitting and walking on the first day if the saturation is correct, and respiratory physiotherapy is recommended during their hospital stay. A control chest X-ray is recommended the day after surgery and prior to hospital discharge.

Results

Between January 2012 and June 2016, 31 patients – 16 women and 15 men – underwent surgery in our hospital with a MIS retropleural approach. Their mean age was 58 [25–84] years. In 5 patients resection of thoracic herniation was performed, in 16 patients fixation of thoraco-lumbar fracture, in 5 patients correction of kyphosis after thoracic fracture sequela, in 3 patients intersomatic cages were implanted for the correction of degenerative deformities, and in 2 cases treatment for discitis was performed. Table 1 contains the different techniques employed.

Twenty six approaches were left-sided and 5 were right-sided due to the requirements of the pathology involved. Mean time in surgery was 225 [120–340] min, and mean intraoperative bleeding was 274 [50–1.200] ml. Fig. 3 illustrates one of the cases (case 25).

In 8 cases an opening of the pleura occurred during the approach. In 2 patients the pleura was sutured, in the other 6 cases a thoracic draining tube was inserted which was removed after 48 h. As a result, 24 patients were able to initiate early mobilization one day after surgery because they did not require pleural drainage.

No major pulmonary complications associated with pleural opening during the postoperative period were recorded (atelectasis, pneumonia, pleural effusion, pneumothorax...). No other intraoperative complications were recorded (large blood vessel injuries,

Table 1 Techniques used.

Case	Sex	Age	Diagnosis	Segment	Side approach	Surgical technique	Posterior approach	Time in surgery (min)	Bleeding (ml)	Intraoperative pleural opening	Hospital stay (days)	Complications	Transfusion	Further surgery
1	W	75	Thoracic disc herniation	T11–T12	Left	Discectomy + peek cage implant (DLIF)	Open decompression T11–T12+	120	70	No	3	No	No	No
2	W	62	Discitis	L1–L2	Left	Discectomy + canal decompression + gentamicin titanium mesh implants	Percutaneous fixation L1–L3	150	50	No	9 (iv antibiotic)	No	No	No
3	W	36	TL fracture sequela	L1	Left	Partial vertebrectomy + expandable replacement	Percutaneous fixation T12–L2	210	300	No	6	No	No	No
4	W	49	Adult scoliosis	L1–L3	Left	Discectomy + peek cage implant (DLIF)	No	120	50	No	3	No	No	No
5	M	53	Blow-out Fracture	T9	Right	Partial vertebrectomy + T9 titanium mesh + T8–T10 platelet	No	200	550	No	12	Pleural effusion (thoracocontesis)	No	No
6	W	63	Blow-out fracture	T12	Left	Partial vertebrectomy + T12 mesh + T11–L1 platelet	No	200	400	No	7	No	No	No
7	M	37	Blow-out fracture	T9	Left	Partial vertebrectomy + T9 mesh + T8–T10 platelet	No	240	200	Yes	5	No	No	No
8	W	70	TL fracture sequela	T12	Right	Partial vertebrectomy + T12 mesh + T11–L1 platelet	No	230	400	No	10	Slight pleural effusion	Yes	No
9	W	54	Thoracic disc herniation	T9–T10	Right	Herniation resection	No	250	1.200	No	5	No	No	No
10	M	52	Blow-out fracture	L1	Left	Partial vertebrectomy + L1 expandable replacement + T12–L2 platelet	No	230	400	No	7	No	No	No
11	W	84	Blow-out fracture	T12	Left	Partial vertebrectomy + T12 expandable replacement + T11–L1 platelet	No	220	100	No	18	Pleural effusion (thoracocontesis)	Yes	No
12	M	65	Blow-out fracture	T7	Left	Partial vertebrectomy T7 + T6–T8 platelet	Percutaneous fixation T5–T9	240	300	No	10	No	No	No
13	W	30	Blow-out fracture	L1	Left	Partial vertebrectomy + L1 expandable replacement + T12–L2 platelet	No	220	150	No	13 (polytrauma)	No	Yes	No
14	W	77	Blow-out fracture	L1	Left	Partial vertebrectomy + L1 expandable replacement	No	230	150	Yes	7	No	No	No
15	W	52	Blow-out fracture	L1	Left	Partial vertebrectomy + L1 expandable replacement + T12–L2 platelet	No	210	200	Yes (sutured)	4	No	No	No
16	M	43	Thoracic disc herniation	T12–L1	Left	Herniation resection	No	200	250	No	5	No	No	No
17	M	58	Blow-out fracture	T12	Left	Partial vertebrectomy + T12 expandable replacement + T11–L1 platelet	No	240	350	No	5	No	No	No

Table 1 (Continued)

Case	Sex	Age	Diagnosis	Segment	Side approach	Surgical technique	Posterior approach	Time in surgery (min)	Bleeding (ml)	Intraoperative pleural opening	Hospital stay (days)	Complications	Transfusion	Further surgery
18	W	69	Kyphosis	T9–L2	Left	Discectomy T11–L1 + peek cage implant (DLIF)	Yes (percutaneous T9–L2)	230	150	No	12	Retropleural haematoma, pneumothorax	Yes	Yes
19	W	60	Thoracic disc herniation	T10–T11	Right	Herniation resection	No	200	250	Yes (massive)	3	Intercostal pain	No	No
20	W	60	TL fracture sequela	T12	Left	Partial vertebrectomy + T12 expandable replacement + T11–L1 placement	No	150	400	No	7	Intercostal pain	No	No
21	W	70	Discitis (sequela)	T12–L1	Left	Partial vertebrectomy + anterior release + mesh L1 + T12–L2 platelet	No	150	400	No	3	No	No	No
22	M	61	Blow-out fracture	L1	Left	Partial vertebrectomy + L1 mesh + T12–L2 platelet	No	250	300	No	6	No	No	No
23	W	78	TL fracture sequela	L1	Left	Partial vertebrectomy + expandable replacement L1 + single axial screw T12–L2 with bar	Yes (percutaneous T12–L2)	220	250	Yes	7	No	No	No
24	M	63	Blow-out fracture	L1	Left	Partial vertebrectomy + expandable replacement expansible L1	Yes (percutaneous T12–L2)	300	200	Yes (sutured)	5	No	No	No
25	M	44	Blow-out fracture	L1	Left	Partial vertebrectomy with opening of diaphragm in cross and transpoas + expandable replacement L1	Yes (percutaneous T12–L2)	310	220	No	9	No	No	No
26	M	25	Blow-out fracture	L1	Left	Partial vertebrectomy + expandable replacement L1	Yes (percutaneous T12–L2)	290	240	No	5	No	No	No
27	M	54	Blow-out fracture	T7	Left	Partial vertebrectomy + expandable replacement T7	No	320	200	Yes	8	No	No	No
28	M	74	Degenerative disc disease	T12–L2	Left	Discectomy + peek cage implant (DLIF)	No	200	150	No	3	No	No	No
29	M	75	Blow-out fracture	T12	left	Partial vertebrectomy + expandable replacement T12	Yes (percutaneous T11–L1)	300	250	No	7	Intercostal pain	No	No
30	M	51	Thoracic disc herniation	T12–L1	Right	Resection herniation	No	230	180	Si (massive)	4	No	No	No
31	M	55	TL fracture sequela	L1	Left	Partial vertebrectomy + expandable replacement L1	Yes (percutaneous T11–L3)	340	200	No	6	DVT	No	No

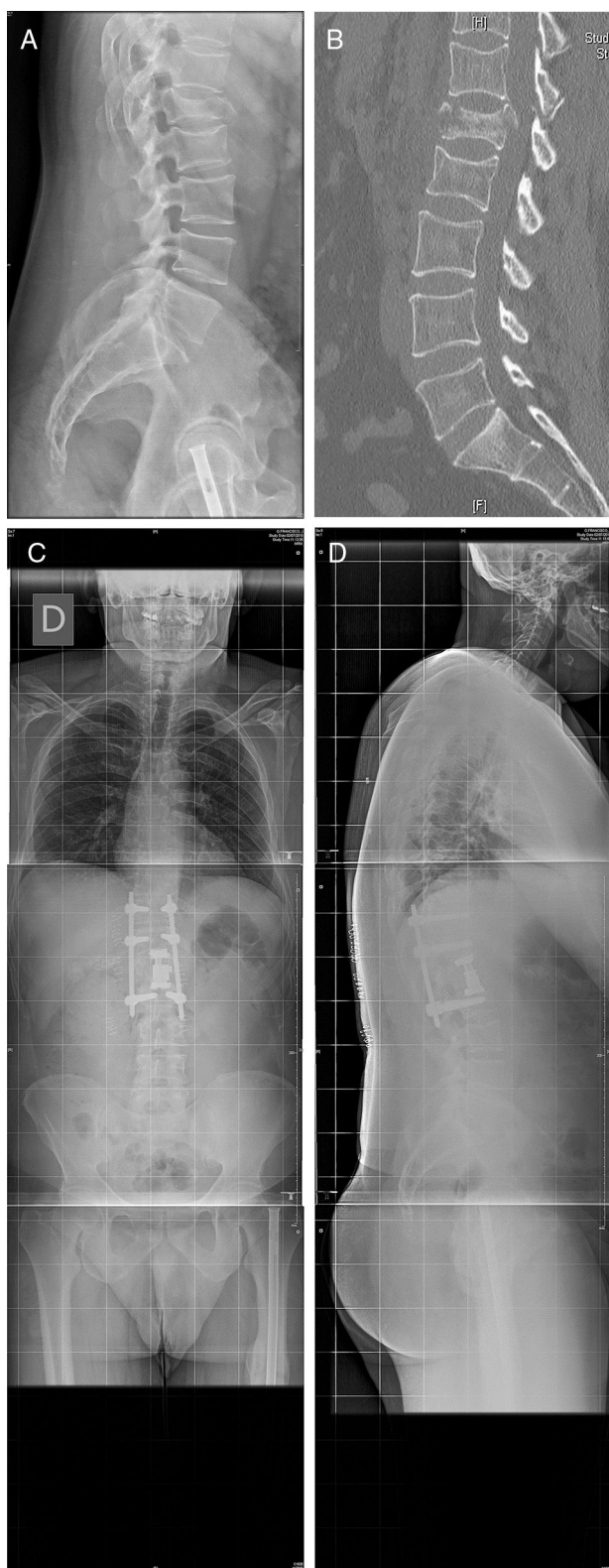


Figure 3 Case 25: Blow-out fracture L1 in polytraumatised patient in a traffic accident (A). The TC (B) is compromised in the posterior wall and there is comminution. We therefore decided to perform surgery with a double approach: retropleural corpectomy and the insertion of a vertebral replacement, with posterior fixation using percutaneous screws (C, D). No pleural opening took place during surgery and there were no complications during the postoperative and follow-up periods.

medular-radicular injury ...) and in no case did surgery have to be converted from minimally invasive to an open surgery technique.

In the immediate postoperative period only 4 of the 31 patients (13%) required a transfusion of 2 packed red blood cells.

In the control X-ray after 24h in 3 of the cases without intraoperative opening of the pleura a minimal effusion in the thoracic cavity was detected: in one case the patient was asymptomatic and this was interpreted as reactive pleuritis and was resolved spontaneously without the need for thoracocentesis prior to hospital discharge. In the other two cases the effusion caused mild dyspnoea which improved after thoracocentesis of the serohaematic fluid.

The most notable pulmonary complications in our series was a case of retropleural haematoma caused by bleeding of the intercostal bundle and complicated with a pneumothorax and severe dyspnoea which required surgical review on the second postoperative day, with drainage of the haematoma, ligation of the bleeding vessel and the insertion of an endothoracic tube. The patient evolved favourably and was discharged 6 days after surgery when a chest X-ray was normal.

The only major non pulmonary surgical complication in the series was a case of DVT and there were 3 cases of minor complications of intercostal pain, which improved with anti-inflammatory treatment. Mean hospital stay was 6.7 days.

No complications were detected during follow-up in the doctor's surgery nor did any of the patients receive further surgical treatment for complications relating to this surgical approach.

Discussion

In this first series of 31 cases we confirmed that the minimally invasive retropleural approach provides good vision of the anterolateral spine, using a similar working angle to the mini-thoracotomy and this allows for the segmental arteries to be ligated in the case of vertebrectomy, expanding up to L1–L2 when necessary, using light de-insertion of the diaphragm. Furthermore, unlike thoracoscopy implants may be inserted through the same incision and this allows for the use of surgical microscopy with observation of the surgical field increased three-dimensionally. As a result of all of these technical reasons this approach may now be used for the treatment of multiple pathologies, such as thoracic herniation resection, the treatment of thoraco-lumbar fractures, degenerative pathologies, treatment of infections and tumours and correction of deformities.^{2,6,7,13,14} The main advantage associated with the retropleural approach is that it does not invade the pleural space, and the percentage of postoperative pulmonary complications is therefore lower.^{1,3,4,6,12}

In our series the only recorded intraoperative complications was the opening of the pleura during surgery, which occurred in 8 cases, out of which none led to complications during the postoperative and follow-up period. The pulmonary complications described occurred in patients without pleural opening during the approach, although in the two symptomatic cases which required

thoracocentesis the effusion could have been related to the unnoticed opening of the pleura intraoperatively. There were no postoperative cases of pneumonia or atelectasis, and the percentage of pulmonary complications in our series was 6.5%.

The general percentage of pulmonary complications described in the MIS published series is low, similar to our series. In a series of 38 patients, who mostly underwent surgery for tumours, Scheufler⁶ refers to 11 sutured pleural openings, and only in 2 cases was postoperative endothoracic tubing required, one due to the pleural opening and the other due to the postsurgical pleural effusion. He refers also to 2 cases of postoperative atelectasis. Moran et al. Recorded 5 suturable pleural openings during the approach in the treatment of 17 cases of giant thoracic herniation, with the need for endothoracic tubes in one case.³ Baaj et al.,² in their series of 80 cases, published a global rate of complications of 12.5%, with specifically pulmonary complications being 3% of the total, with one case of haemothorax and another of pleural effusion.

One of the minor complications described in anterior approaches is intercostal neuralgia. The MIS retropleural approach requires minimal costal resection and it is also possible to perform it with intercostal entry with dilators, where there is a lower risk of intercostal nerve damage and therefore a lower rate of postoperative intercostal neuralgia compared with thoracotomy.^{3,4,6,13,14} In our series there were only 3 cases of intercostal neuralgia which was relieved in under one month with NSAIDs (3%), a percentage that is similar to other published series, with only one or two cases.^{2,6,7}

No other major intraoperative complications were recorded (large blood vessel damage, dural opening, medullary radicular damage ...). There was only one case of DVT immediately after surgery. In no case did the surgery have to be converted from minimally invasive to an open technique and there was only one case of surgical revision, which has been described above.

The major complication most frequently described in the literature is the opening of the dura mater to the thoracic cavity,^{3,6} with the technical difficulty required for repair of the cerebrospinal fluid (CSF) fistula in these cases. We were unable to confirm the theoretical advantage of not opening the pleura since we did not record dura mater injury in any cases, but we agree that if the pleura is to remain whole, dealing with CSF fistulas in the thoracic cavity, should they arise, is technically simpler.

In our series mean intraoperative bleeding was 274 ml, with a low rate of transfusion (13%). If bleeding was higher than expected (1.200 ml) this was due to the comorbidities of the patient. Scheufler⁶ estimates mean bleeding of 280 ml and Patel et al.⁷ of 200 ml. Our series is therefore within the range published up until now.

Hospital stay was 6.7 days in our series. In the series by Patel et al.,⁷ which only includes degenerative pathologies, hospital stay was 4 days. The increase in hospital stay in our series was possibly due to the fact that the majority of cases underwent surgery for thoraco-lumbar fractures and correction of deformities. Low hospital stay was possible because not all cases required a thorax tube after surgery, and this allowed for the patient to rapidly start moving, leading to early postoperative recovery.^{1,3,12}

In our series the mean time in surgery was 225 min. Due to the scarcity of publications in this regard it is difficult for us to compare this aspect. Scheufler⁶ published a mean time in surgery of 163 min, whilst Uribe et al.,⁴ with only 4 cases, published a mean time of 300 min. This surgical technique is demanding and has a long learning curve. In our case we presented the first 31 patients who underwent this type of surgery in our hospital, and it is therefore probable that the time in surgery would be lower in the future, as would the number of cases of intraoperative pleural opening.

Among the limitations for this study are a short series of cases where a retrospective review of data acquired prospectively was made, without a control group or comparison with other series where thoracotomy or thoracoscopy was used. Since this was an initial series different diagnoses and techniques were mixed together, which would definitely have had an influence on bleeding and time in surgery. Our current objective was to assess the pulmonary complications associated with the approach and assess their safety profile. A comparative study between pathologies is therefore necessary when future larger patient series are used. Despite the before-mentioned limitations, no article has yet been published which specifically assesses pulmonary complications relating to the advantage of the retropleural approach in maintaining the pleura intact.

Conclusion

The retropleural approach facilitates observation of the anterolateral spine and the performing of corpectomy and decompression of the medullary canal, with a lower general rate of complications compared with the open transthoracic approach. The rate of complications is comparable to thoracoscopic techniques, with the advantage of increased three-dimensional vision using a microscope, and the possibility of inserting implants without the need for additional incision. Bleeding and hospital stay is lower because this is a minimally invasive technique. It does, however, require a long learning curve.

Level of evidence

Level of evidence 4.

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