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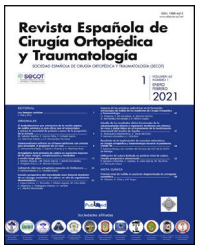

SPINAL MONOGRAPH

[Translated article] The role of minimally invasive spine surgery in the treatment of vertebral metastasis (Part 1): A clinical review

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KEYWORDS
Spinal metastasis;
Minimally invasive spine surgery;
Open surgery

Abstract Spinal metastases represent a significant burden on the quality of life in patients affected by active oncological disease due to the high incidence of pain syndromes, spinal deformity, and neurological impairment. Surgery plays a decisive role in improving quality of life by controlling pain, restoring neurological function and maintaining spinal stability, as well as contributing to the response to medical therapy. Minimally invasive surgery (MIS) is a treatment option in certain patients with high surgical risk since it has a low rate of complications, intraoperative bleeding, hospital stay, and offers similar results to open surgery.

In this review, we present the role of MIS in this pathology and some cases treated in our hospital.

PALABRAS CLAVE
Metástasis espinal;
Cirugía mínimamente invasiva;
Cirugía abierta

El papel de la cirugía mínimamente invasiva de columna en el tratamiento de las metástasis vertebrales (parte 1): una revisión clínica

Resumen Las metástasis espinales representan una importante carga sobre la calidad de vida en los pacientes afectados por una enfermedad oncológica activa, debido a la alta incidencia de síndromes dolorosos, deformidad espinal y deterioro neurológico. La cirugía juega un papel determinante a la hora de mejorar la calidad de vida mediante el control del dolor, el restablecimiento de la función neurológica y el mantenimiento de la estabilidad espinal,

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además de contribuir a la respuesta de la terapia médica. La cirugía mínimamente invasiva es una opción de tratamiento en determinados pacientes con alto riesgo quirúrgico, ya que tiene una baja tasa de complicaciones, de sangrado intraoperatorio, de estancia hospitalaria y ofrece resultados similares a la cirugía abierta.

Presentamos en esta revisión el papel de la cirugía mínimamente invasiva en esta enfermedad, y algunos casos tratados en nuestro centro hospitalario.

Introduction

In the USA, 1.6 million new cases of cancer are diagnosed annually, with a mortality rate of about 50%, and significant disease-related burden.[1,2] Spinal metastatic involvement is one of the most frequent complications of oncological disease, and is increasingly prevalent due to improved complementary treatments (chemotherapy and hormone therapy, among others) resulting in improved patient survival.[3] After lung and liver involvement, the spine is the most frequent site of metastasis, mainly secondary to prostate, lung, and breast tumours, the latter two being the most frequent primary neoplasms.[4] Between 30% and 90% of cancer patients develop spinal metastases; however, despite their high prevalence, only 10% of these patients have symptoms associated with metastatic involvement, 50% require some form of treatment, and between 5% and 10% require surgical treatment.[5]

Spinal involvement

There are different mechanisms of tumour dissemination. These are primarily haematogenous, contiguous invasion, or pathological seeding in the cerebrospinal fluid (CSF).[3] This dissemination is closely related to the nature and behaviour of the primary tumour, and haematogenous dissemination is the most frequent mechanism due to the important arterial vascularisation of the vertebral bodies, which enables tumour cells to migrate from their site of origin to the vertebral body where the metastatic deposit occurs. Dissemination through Batson's venous plexus is also possible due to the extensive communication between this structure and other venous drainage beds (portal system, azygos vein, intercostal veins, vena cava, renal vein, among others), which facilitates the lodging of tumour cells.[6] Whether secondary to the arterial or venous route, it is important to bear in mind that this type of dissemination leads to multicentric spinal involvement.[5]

Clinical presentation

The clinical presentation of spinal metastases can vary. However, the predominant symptom in patients with spinal involvement is pain, present in up to 95% of cases,[5,7] which may be local, mechanical, or radicular. This symptom may precede the onset of neurological symptoms by days to weeks. Careful assessment of pain characteristics is vital to differentiate between local pain secondary to tumour growth, mechanical pain secondary to impending or established segmental instability, and radicular or spinal symptoms associated with compression of neurological structures.[5]

Motor dysfunction is the second most common symptom in spinal metastatic involvement. Weakness in one or more muscle groups is present in up to 85% of patients at diagnosis and may be due to myelopathy, radiculopathy, or a combination of both.[7]

Treatment

There are different treatment modalities for spinal metastases (chemo-radiotherapy, radiosurgery, among others) and medical specialties. The therapeutic decision also depends on multiple factors, including the clinical condition of the patient (assessable using the Karnofsky Performance Score),[8] life expectancy,[8–10] location, and control of the primary tumour, the predominant symptoms of metastatic involvement, the extent of spinal involvement, among others; a surgical decision is acceptable in patients with a life expectancy of more than 3–6 months.[11]

In most cases, the spine is one of the multiple organs affected by oncological activity, and therefore the main objective of medical and surgical treatment is not curative but palliative, to ensure the patient's safety and quality of life.[11–14]

Surgical treatment of spinal metastases should aim to improve or cure pain, maintain, or improve neurological function, and maintain or restore spinal stability (surgery being the only means available) in a way that is long-lasting, considering the patient's life expectancy, with an acceptable morbidity rate.[3]

The Spine Oncology Study Group (SOSG) defines neoplastic spinal instability as the ''loss of spinal integrity as a result of a neoplastic process that is associated with movement-related pain, symptomatic or progressive deformity and/or neurological compromise under physiological loads''.[15]

The presence of spinal instability is a surgical indication for stabilisation irrespective of the degree of epidural compression (assessable using the ESCC scale). This degree of instability is assessed using the Spine Instability Neoplastic Score (SINS) score (Table 1), which assesses clinical and radiographic parameters and, although it does not recommend any specific type of treatment, it enables the surgeon

Table 1 SINS.

Component	Description	Score
Location	Occipital-C2, C7-T12, T11-L1 or L5-S1	3
	Mobile spine (C3–C6, L2–L4)	2
	Semi-rigid spine (T3–T10)	1
	Rigid spine (S2–S5)	0
Pain	Yes	3
	Occasional mechanical pain	1
	Painless	0
Bone lesion	Lytic	2
	Mixed (lythic/blastic)	1
	Blastic	0
Radiographic spinal alignment	Subluxation/translation	4
	New deformity (kyphosis/scoliosis)	2
	Normal	0
Vertebral body collapse	>50%	3
	<50%	2
	No collapse with >50% body involved	1
	None of the above	0
Posterolateral involvement	Bilateral	3
	Unilateral	1
	None of the above	0

SINS: Spinal Instability Neoplastic Score.

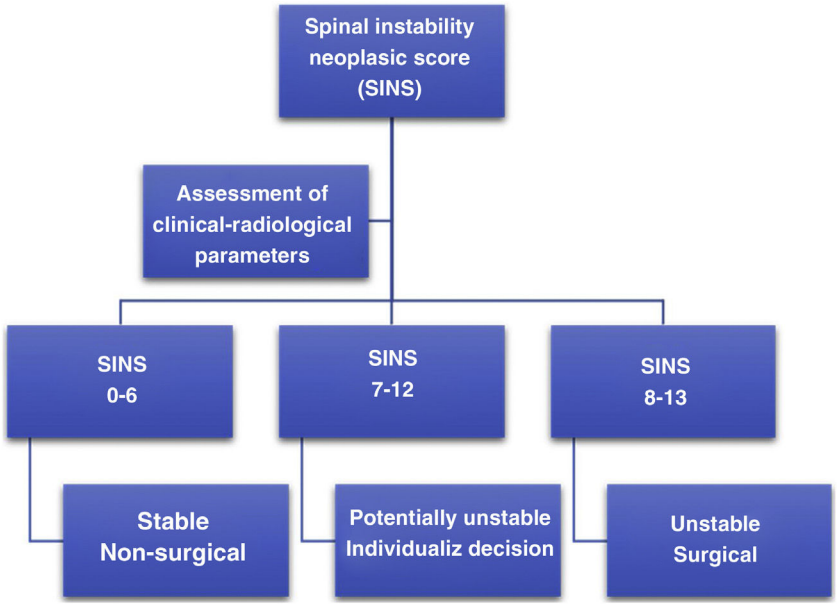

Figure 1 Spinal Instability Neoplastic Score (SINS). The Spinal Instability Neoplastic Score helps in the assessment of tumour-related spinal instability. A SINS of 7–18 requires surgical assessment to evaluate spinal instability before proceeding with any planned radiation treatment.

to identify and treat those patients who may be at risk of developing spinal instability and secondary deformities[15] (Fig. 1).

Advances in surgical techniques have resulted in the development of minimally invasive surgery (MIS) as an alternative to open surgery in the treatment of spinal oncological disease, ensuring better preservation of adjacent muscle tissue, reduced operative blood loss, shorter hospital stay, better pain control, and reduced postoperative opioid consumption. In general, it offers patients faster and better-quality recovery.[2,16]

Table 2 Comparative studies between MIS and OS for the treatment of spinal metastases.

		Patients (*n*)							Minimally invasive surgery					Open surgery					Statistical differences
Author	Year	OS	MIS	Surgical indication	Surgical procedure	Location	Surgical outcome included	Post-operative outcome included	Surgery time (min)	Blood loss (ml)	Pre/post VAS	Global survival	Complications.	Surgery time	Blood loss	Pre/post VAS	Global survival	Complications	
Huang et al.	2006	17	29	Untreatable pain, neurological deficit	MIS corpectomy vs. open corpectomy	T3-T12	Surgery time (min), blood loss (ml)	Stay in ICU, neurological function	179 (120–250)	1100 (200–4300)	/	27.4 (1–82) months	20.6% ($n=6$) CSF fistula, pneumothorax, pseudoarthrosis, tumour recurrence, tumour progression,	180 (120–315)	1162 (300–3.000)	/	24.8 (1–76)	29% ($n=5$) sepsis, pneumonia, urinary tract infection, pneumothorax, gastrointestinal bleeding	Stay in ICU MIS ($n=2$) vs. open surgery ($n=12$) ($p \leq .0001$)
Fang et al.	2012	17	24	Neurological deficit, untreatable pain or imminent or present fracture	Mini-open corpectomy vs. open spondylectomy	T5-L2	Surgery duration (min), blood loss (ml)	Global survival (months), neurological function (ASIA), visual analogue scale (VAS)	175 ± 38	1058 ± 263	8.5/1.5	19.8 ± 8.8 months (range: 6–36 months)	29.2% ($n=7$) (pleural effusion, intercostal neuralgia, atelectasis, wound infection)	403 ± 55	1721 ± 293	8.5/2	15.3 ± 3.9 months (range: 8–24 months)	11.8% ($n=2$) CSF fistula, worsened ASIA	Surgery time ($p=.0001$), blood loss ($p=.0001$)
Lau et al.	2015	28	21	Spinal instability, oncological treatment failure, spinal cord compression, neurological deficit	Mini-open corpectomy vs. open corpectomy	Thoracic spine	Surgery duration (min), blood loss (ml)	Hospital stay, neurological function (ASIA)	452.4	916.7	/	/	9.5%. Any unexpected event requiring medical or surgical treatment within the first 30 peri-operative days	413.6	1697.3	/	/	21.4% any unexpected event requiring medical or surgical treatment within the first 30 peri-operative days	Blood loss ($p=.019$). Hospital stay MIS (7.4 days) vs. open surgery (11.4 dias) ($p=.001$)
Miscusi et al.	2015	19	23	Acute myelopathy	Laminectomy MIS + percutaneous arthrodesis vs. open laminectomy + arthrodesis	Thoracic spine	Surgery duration (min), blood loss (ml)	Neurological function (ASIA), visual analogue scale (VAS), quality of life (QOLC-30)	132 (90–180)	240 (180–400)	Improved 74% to stable 22%	/	4.3% ($n=1$) urinary tract infection	192 (150–270)	900 (350–1500)	Improved 53% to stable 37%	/	0%	Pre- and post-operative pain ($p=.007$). Blood loss ($p=.01$). Surgery time ($p=.01$). Transfusions MIS $n=0$) vs. open surgery ($n=12$) ($p=.01$). Improved QOL MIS vs. open surgery ($p=.009$)

Table 2 (*Continued*)

Author	Year	Patients (*n*) OS	MIS	Surgical indication	Surgical procedure	Location	Surgical outcome included	Post-operative outcome included	Minimally invasive surgery: Surgery time (min)	Blood loss (ml)	Pre/post VAS	Global survival	Complications.	Open surgery: Surgery time	Blood loss	Pre/post VAS	Global survival	Complications	Statistical differences
Hansen-Algenstaedt et al.	2017	30	30	Instability, untreatable pain. Neurological compression (deficit or pain), progressive deformity	Laminectomy ± corpectomy (thorascopy – XLIF) + percutaneous arthrodesis vs. laminectomy ± corpectomy + open arthrodesis	/	Surgery duration (min), blood loss (ml), instrumented segments, decompressed segments, fluoroscopy (s)	VAS, hospital stay, transfused patients, ASIA	190.9 ± 78.4	1156.0 ± 572.3	6.7 ± 2.2/1.5 ± 2.2		23.3% (*n* = 7) CSF fistula, pneumonia, urinary tract infection, neurological impairment	220.4 ± 57.9	2062.1 ± 1148.0	7.0 ± 2.5/2.4 ± 2.1		40% (*n* = 12) surgical wound infection, CSF fistula, pneumonia, urinary tract infection, neurological impairment	Instrumented segments MIS (5.5 ± 3.1) vs. open surgery (3.8 ± 1.7) ($p = .012$). Blood loss ($p \leq .001$). Transfused patients MIS (40 vs. 76.7%) ($p = .002$). Fluoroscopy MIS (116 s) vs. open surgery (69 s) ($p = .002$). Hospital stay MIS (11 ± 5) vs. open surgery (21.1 ± .8) ($p \leq .001$)
Hikata et al.	2017	25	25	Untreatable pain, instability, pathological fracture	Laminectomy + percutaneous arthrodesis vs. laminectomy + open arthrodesis	Thoraco-lumbar	Surgery duration (min), blood loss (ml)	VAS, neurological status (Frankel)	204.6 ± 55.4	340.1 ± 302.5	7.3 ± 2.4/ 2.7 ± 2.8	28% at end of follow-up (9.9 ± 8.2 months)	12% (*n* = 3) surgical bed haematoma, neurological deficit, massive bleed (>1000 ml)	188.9 ± 43.6	714.3 ± 545.9	7.2 ± 2.9/2.2 ± 1.3	30% at the end of follow-up (11.0 ± 11.8 months)	44% (*n* = 11) massive bleed (>1000 ml), surgical bed haematoma, neurological deficit	Blood loss ($p = .005$). Bedrest MIS (2.0 ± 1.5 days) vs. open surgery (3.6 ± 1.6 days) ($p \leq .001$)
Kumar et al.	2017	18	27	Neurological deficit and/or spinal instability	Laminectomy + percutaneous arthrodesis vs. laminectomy + open arthrodesis	/	Surgery duration (min), blood loss (ml), number of screws, decompressed levels	VAS, neurological status (Frankel), hospital stay	253 (215–290)	184 (121–247)	7 ± 2.1/ 1.8 ± 1.5	7.5 months (8d–20 months)	3% surgical wound infection	269 (217–321)	961 (548–1374)	7 ± 2.8/ 3.5 ± 2.0	12 months (1–48 months)	16% surgical wound infection	Blood loss ($p \leq .001$). Pain control pre- and post-operative VAS ($p \leq .001$)
Saadeh et al.	2019	20	20	Untreatable pain, spinal instability, neurological impairment, spinal cord compression	Laminectomy ± mini-open corpectomy + mini-open arthrodesis vs. Laminectomy ± corpectomy + open arthrodesis	Cervico-thoracic-lumbar	Surgery duration (min), blood loss (ml)	VAS, ASIA, hospital stay	296 ± 16	805 ± 138	Decrease 1.71 points ± .5	6 months	30%	266 ± 26	1732 ± 359	Increase .33 points ± .7	8 months	45%	Blood loss ($p = .019$). Greater postoperative pain in open surgery ($p = .018$)
Morgen et al.	2022	26	23	Spinal cord compression	Laminectomy + percutaneous arthrodesis vs. laminectomy + open arthrodesis	T5-L3	Surgery duration (min), blood loss (ml)	Global survival (months)	142 (72–203)	175 (30–800)	/	21.3 (1.3–49.9) months	8.6% (*n* = 2)	103 (59–435)	500 (100–2.000)	/	15.3 months (.96–45.5)	7.69% (*n* = 2)	Blood loss ($p = .002$). Surgery time ($p = .01$).

MIS: minimally invasive surgery; OS: open surgery; VAS: visual analogue scale.

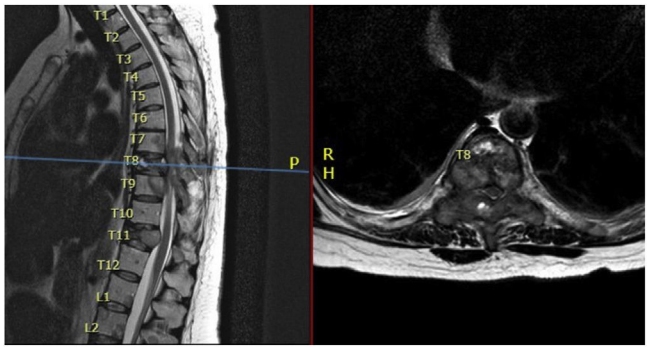

Figure 2 Sagittal (left) and axial (right) T2-weighted sequence of dorsolumbar MRI showing multiple metastatic lesions with lesion in D8 invading the spinal canal, vertebral body, pedicles, transverse process, and lamina.

Comparison of the results of open surgery vs. MIS shows, in addition to the abovementioned benefits, that there is a similar rate of results in terms of neurological improvement,[17–21] which could demonstrate that MIS is a viable therapeutic option in certain patients who are not suitable for open surgery due to age, frailty, comorbidities, extent of disease, or low life expectancy, and is considered part of combined multidisciplinary treatment (separation surgery). However, these results should be interpreted with caution as there is currently a lack of level I evidence to make a strong recommendation on the widespread use of MIS,[11] and therefore each case must be tailored to the individual.

To date, we have found 9 studies published in the literature comparing open surgery vs. MIS in the treatment of spinal metastases. These are shown in Table 2.

Clinical case 1

A 46-year-old woman with a history of breast cancer attended the emergency department for progressive loss of strength in the lower limbs until she was unable to ambulate at <24 h (SOSG) from onset.

Physical examination: Lower limb (R/L): hip flexion 3-/3-, hip extension 5/5, knee extension 5/5, knee flexion 5/5, dorsal and plantar flexion 5/5, and sensory level D6.

An emergency MRI of the dorsal spine was performed, which showed multilevel involvement of the dorsal spine (infiltrative lesions) also associated with pathological fractures at levels D8 and D11; causing spinal cord compression at D8 level with radiological myelopathy from D7 to D9 (Fig. 2).

Emergency surgical treatment was performed by unipedicular left kyphoplasty D7, D8, and D9 (because the right pedicle was destroyed by tumour mass) and bilateral pedicular D10–D11 (Fig. 3). Minimally invasive ''over the top'' D8–D9 laminectomy, entering on the right side and performing bilateral decompression through a unilateral approach, with resection of the posterior epidural tumour, of fibrous consistency, highly vascularised, and adherent to the dura mater. Intraoperative blood loss was 40 cc and surgical time was 3 h.

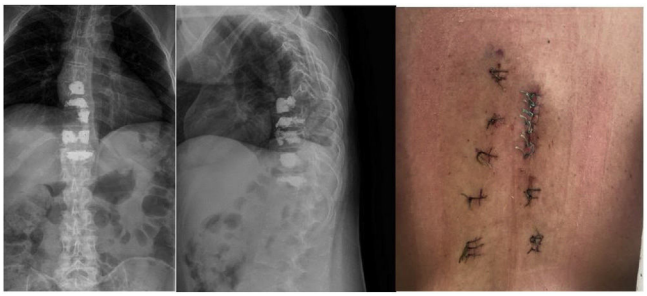

Figure 3 Postoperative AP (left)/lateral (centre) dorsolumbar X-ray and dorsolumbar percutaneous wounds (right).

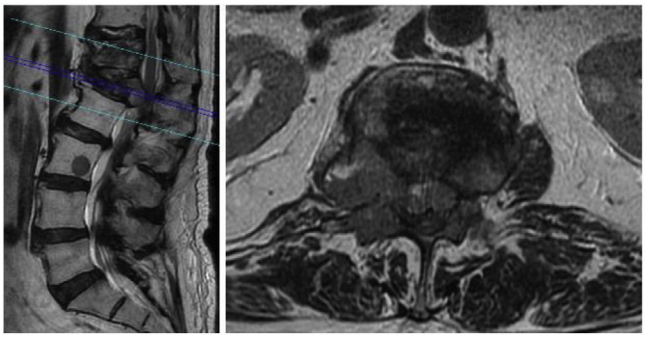

Figure 4 Sagittal (left image) and axial (right image with cut at L1) T2-weighted sequence of dorsolumbar MRI showing metastatic lesions at D12, L1, L3 with compression of the conus medullaris at L1 level by tumour mass anterior to the thecal sac and by pedicle invasion.

The postoperative period was uneventful, and the patient made good general progress over the 10-month follow-up period, with progressive improvement of strength in the lower limbs and recovery of sensory level at the level of D11.

Clinical case 2

A 69-year-old man with a history of stage IV lung carcinoma and overweight, who attended the emergency department for disabling dorsolumbar pain refractory to the usual analgesia. An MRI scan was performed which showed a metastatic L1 lesion without fracture. He was treated by the oncology department with palliative radiotherapy and a dorsolumbar brace. One year after this treatment, he was readmitted for disabling pain without evidence of neurological deficit, with clinical pain, and disability scales VAS 10/10 and ODI 78/100. He was on fentanyl patches 75 μg/h and oral morphine sulphate (MST) 90 mg/every 12 h for pain management.

During his admission, he underwent a further MRI, which showed L1 fracture with posterior wall rupture, invasion of the spinal canal and compression of the conus medullaris (Fig. 4). In addition, there was evidence of multilevel metastatic involvement (D12 involvement with wedging of the superior plate and 2 other foci at L3 and L5, without fracture). He required intravenous perfusion of morphine chloride at 10 mg/h for incapacitating pain.

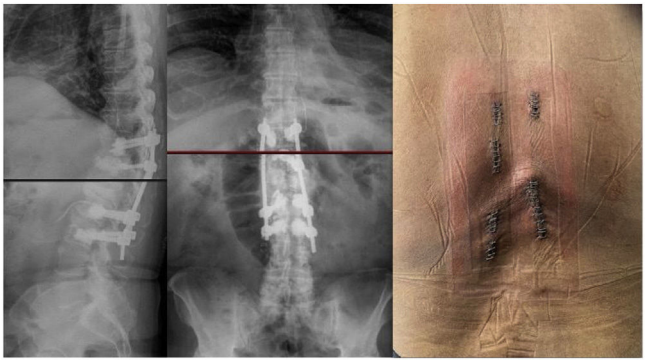

Figure 5 Postoperative lateral (left image)/AP (centre image) X-rays and percutaneous wounds (right image).

MIS was decided and an ''over the top'' L1 laminectomy was performed, preferring the right side due to the greater tumour involvement evident on the MRI and bilateral decompression through a unilateral approach, left unipedicular D12 kyphoplasty and percutaneous transpedicular fixation of bilateral D11, left unilateral D12, bilateral L2 and L3 (Fig. 5) with intraoperative blood loss of less than 30 cc, and surgery time of 4 h.

The patient made good postoperative progress, with a follow-up of 6 months, no postoperative complications (neurological deficit or wound dehiscence) and it was possible to progressively decrease intravenous opioids achieving optimal analgesia with oral MST 10 mg/every 12 h, with postoperative assessment scales of VAS: 3/10 and ODI: 38/100.

Clinical case 3

A 72-year-old woman with a history of ovarian cancer and overweight, admitted to another hospital for disabling dorsolumbar pain managed with usual analgesia and fentanyl patch 50 μg/72 h, requiring intravenous perfusion of morphine chloride at 6 mg/h, and transferred to our centre for treatment. On arrival she presented pain scores VAS: 8/10 and disability (ODI): 68/100. Examination showed no neurological deficit.

Dorsolumbar MRI showed metastatic involvement in the vertebral bodies of L1 and L2; with L2 fracture with subsidence of the right L2 plate. At L1 level, invasion of the spinal canal on the left side and left L1 and L2 pedicle fracture (Fig. 6).

MIS surgery was decided, performing a left L1 hemilaminectomy through a left tubular approach, with a heavily bleeding bone lesion, with difficult haemostasis, right L2 kyphoplasty and elevating the upper plate to improve scoliosis and percutaneous transpedicular cemented fixation of bilateral D11 and D12, right L1 and L2, bilateral L3 (Fig. 7). Intraoperative blood loss of 200 cc and surgery time of 4 h.

The patient's postoperative progress was satisfactory, over a follow-up of 3 months she has not presented postoperative complications, the morphine pump and fentanyl patches have been discontinued. The postoperative clinical scores show improvement of pain VAS: 3/10 and ODI: 20/100.

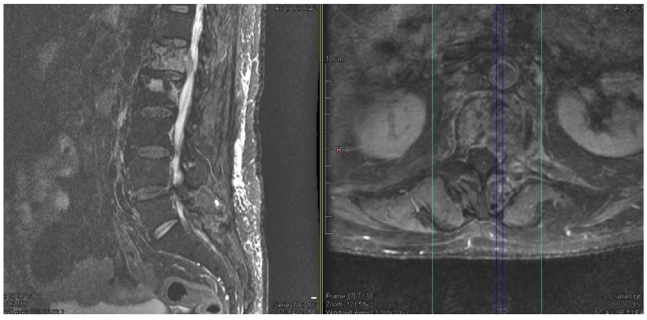

Figure 6 Sagittal (left image) and axial (centre image with cut at L1) T2-weighted sequence of dorsolumbar MRI showing metastatic lesions at L1 and L2 with compression of the conus medullaris at L1 level by tumour mass anterior to the thecal sac and by left pedicle invasion.

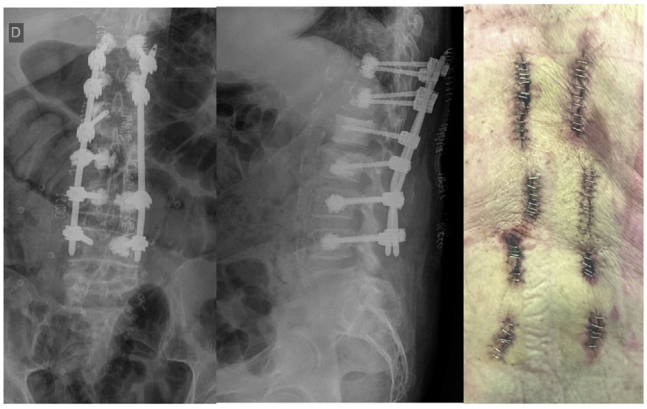

Figure 7 AP (left image) and lateral (central image) X-rays showing bilateral percutaneous cemented fixation D11–D12, right L1–L2, bilateral L3–L4, and percutaneous wounds (right image).

Discussion

MIS in the treatment of selected cases of spinal metastases has revolutionised the traditional surgical treatment of this disease because it has made it possible to safely and effectively intervene in certain patients who previously might not have been considered surgical candidates. MIS offers advantages over classic techniques, including less blood loss and shorter hospital stays (ICU and general hospitalisation), and a downward trend in complications, while offering similar results to open surgery in terms of pain control (assessed using the VAS scale), overall survival, and improvement or preservation of neurological status (assessed using the ASIA and Frankel scales). Only one study, to date, has reported differences in quality of life in favour of MIS over open surgery, which could infer a greater impact of MIS on the quality of life of patients affected by this devastating disease in the final stages of their lives.[21]

However, it is important to point out that mastering the MIS technique requires a significant learning curve. This is reflected in the comparative table of MIS vs. open surgery, which does not show a significant difference in surgical time, and MIS involves time, dedication, and training, variables

that could interfere with outcomes and prolonged surgery times in the first cases.

In selecting the surgical technique, it is important to emphasise the relevance of the direct and indirect costs of each procedure, so as to determine economic differences when choosing the type of procedure.

Metastatic spinal disease poses an economic challenge for healthcare systems due to the high cost of providing treatment. In Europe, specifically in Denmark, costs range from €36,616 to €87,814 per patient over their survival depending on the treatment received, with specific costs of €36,616 (€33,835–€39,583) for conservative treatment; €49,632 (€42,287–€57,767) for decompression surgery; €70,997 (€62,244–€82,354) for decompression surgery + artrodesis and €87,814 (€76,638–€101,528) for decompression + artrodesis + reconstruction surgery, taking into account that the longer the global survival, the higher the cost of care. It is very important to highlight that hospital stay could represent up to 65% of the total expenditure for the patient, and this item is an objective when it comes to reducing direct costs, followed by follow-up visits, which account for up to 31% of total costs.[22]

At present, there are no studies available in the databases reviewed that compare the direct costs of MIS vs. open surgery specifically in the treatment of cancer of the spine.[23] However, there are studies available comparing the associated costs of both techniques in spinal fusion. Lucio et al. evaluated the difference in hospital costs between MIS and open surgery in spinal fusion procedures in 210 patients, 101 undergoing open surgery and 109 undergoing MIS. They found a higher direct instrumental cost for MIS compared to open surgery at 3810.76US$ (approximately €3500), 27% of the total cost of the procedure. However, they observed that the costs for operating theatres, surgical supplies, and expenses associated with hospital stay was lower for MIS over open surgery by 2756.50US$ (56%), 955.64US$ (45%), and 788.51US$ (52%), approximately €2500, €880, and €726, respectively. They also observed a lower rate of transfusions, re-interventions, and residual events (complications), resulting in an estimated reduction of 2825US$ (approximately €2600) at the end of the hospital and surgical process, and an estimated 10% reduction in the total cost of the surgical process.[24]

In another study, Vertuani et al. compared spinal fusion in patients undergoing surgery in the UK and in Italy. Their cost analysis included the resources used for each patient and their procedure, including surgical costs (operating rooms, consumables and prostheses, technical equipment, transfusions, surgical drainage), hospital resources (hospital bed and peri-operative medication), and surgical complications. The direct costs derived from surgical material in Italy for MIS was €3137 compared to €2684 for open surgery, with a difference of €453 in favour of open surgery, and in the UK the associated costs were €2856 vs. €2135 with a difference of €721 in favour of open surgery. Despite a trend towards open surgery being more economically favourable in terms of direct costs associated with instruments, in the United Kingdom a lower total cost associated with MIS vs. open surgery was observed (€13,399 vs. €15,065) and the same phenomenon occurred in Italy (€10,012 vs. €10,985), with a difference in favour of MIS of €1666 and €973 for each country, respectively. This is because a decrease in the rate of complications and transfusions (which are more frequent in open surgery), and a reduction in hospital stay compensates for the increase in the unit value of the material for MIS compared to open surgery. However, despite a trend towards cost-effectiveness of MIS, when the value of MIS material exceeds €4111 per patient in Italy and €4578 in the UK, the cost saving benefit for the healthcare system ceases to exist.[25] It is vitally important to know the budget required for the optimal treatment of each patient, individualising their requirements, because healthcare costs directly impact the sustainability of the system.

Conclusions

There is currently no solid, high-quality evidence to support the widespread use of MIS for the treatment of spinal metastases, but the advantages it offers in terms of early patient recovery, shorter hospital stay, lower risk of postoperative infection, and less postoperative opioid use mean that these approaches can be considered in the management of selected cases of fragile cancer patients. Prospective randomised clinical trials are needed to demonstrate the benefits of MIS surgery over traditional surgery for it to be implemented as routine surgical treatment, because it is currently used only in selected cases.

At present there are no economic studies comparing the cost-benefit of MIS in oncological disease. However, the evidence available on spinal fusion could infer a trend towards lower final health costs using MIS compared to open surgery due to a lower rate of post-surgical complications and blood transfusions, and shorter hospital stay, despite the clearly higher unit cost per patient of the material required to perform MIS compared to open surgery. However, to maintain the cost-efficiency of the surgical indication for MIS, it is important to set a limit on the cost of instruments, because exceeding €4000 per case could result in a loss of economic benefit compared to traditional surgery.

Level of evidence

Level of evidence II.

Conflict of interests

The authors have no conflict of interests to declare.

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